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ТЕМАТИЧЕСКИЙ РЕФЕРАТИВНЫЙ СБОРНИК № 12-2/3

**“Nano Technology”
(«Нанотехнологии»)**

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Публикации в трудах конференций

"A Novel Low-overhead Delay Testing Technique for Arbitrary Two-Pattern Test Application"

With increasing process fluctuations in nano-scale technology, testing for delay faults is becoming essential in manufacturing test to complement stuck-at-fault testing. Design-for-testability techniques, such as enhanced scan are typically associated with considerable overhead in die-area, circuit performance, and power during normal mode of operation. This paper presents a novel test technique, which can be used as an alternative to the enhanced scan based delay fault testing method, with significantly less design overhead. Instead of using an extra latch as in the enhanced scan method, we propose using supply gating at the first level of logic gates to hold the state of a combinational circuit. Experimental results on a set of ISCAS89 benchmarks show an average reduction of 33% in area overhead with an average improvement of 71% in delay overhead and 90% in power overhead during normal mode of operation, compared to the enhanced scan implementation. [C2378]

"Bio-inspired computing architectures: the embryonics approach"

The promise of next-generation computer technologies, such as nano-electronics, implies a number of serious alterations to the design flow of digital circuits. One of the most serious issues is related to circuit layout, as conventional lithographic techniques do not scale to the molecular level. A second important issue concerns fault tolerance: molecular-scale devices will be subject to fault densities that are orders of magnitude greater than silicon-based circuits. In our work, we are investigating a different approach to the design of complex computing systems, inspired by the developmental process of multi-cellular organisms in nature. This approach has led us to define a hierarchical system based on several levels of complexity, ranging from the molecule (modeled by an element of a programmable logic device when the system is applied to silicon) to the organism, defined as an application-specific multi-processor system. By setting aside some of the conventional circuit design priorities, namely size and (to a certain extent) performance, we are able to design fully scalable systems endowed with some properties not commonly found in digital circuits. Most notably, by exploiting a hierarchical self-repair approach, our systems are able to tolerate higher fault densities, whereas a self-replication mechanism allows our arrays of processing elements to self-organize, greatly reducing the layout complexity of the system. [C2379]

"Characterization of thermally conductive epoxy nano composites"

This work aims to develop an anisotropic conductive adhesive (ACA) paste with improved thermal conductivity. ACA consists of a polymer based resin and conductive filler particles. We introduce an electrically insulating but thermally conductive phase into the adhesive. Nano and micro scale particles of alumina oxide, silicon carbide and carbon nanotubes are used with and without surface treatment. The thermal measurements are carried out by transient hot wire method. So far, the thermal conductivity of the epoxy has been increased with more than 100% [C2380]

"Memory technologies in the nano-era: challenges and opportunities"

There have been concerns about how far we can extend the so far so successful conventional semiconductor memories such as DRAM, SRAM and flash memory and what is the future directions of memory development, in this article, we review the key technological limits of conventional memory scaling and the directions to overcome the problem. In addition, we review the technical challenges and opportunities of emerging new memories. [C2381]

"Room temperature soldering of microelectronic components for enhanced thermal performance"

A novel fluxless soldering process is presented, that enables lead-free soldering of semiconductor die-to-heat spreader (and heat spreader-to-heat sink structures) at room temperature. The process is based on the use of reactive multilayer foils to locally melt the solder interface. Silicon-copper samples joined with indium solder are thermally characterized for a range of die sizes and bond line thicknesses. The thermal resistance of the solder joints is found to be an order of magnitude lower than for conventional thermal interface materials (TIMs), with

good thermal fatigue resistance. The predicted thermo-mechanical behavior of the solder interface in a central processing unit (CPU) application indicates that such joints would survive application environments without causing die cracking. The soldering technology employed could greatly enhance the thermal performance of power IC packages such as CPUs, by enabling the adoption of a solder-based TIM between the die and integrated heat spreader. [C2382]

"Direct temperature measurement for VLSI circuits and 3-D modeling of self-heating in sub-0.13 μm SOI technologies"

This paper describes a novel temperature measurement technique which utilizes the gate-poly of the active device as a temperature sensor to directly measure the temperature rise in single- or multi-finger devices commonly used in high performance microprocessors. Measured results are corroborated with 3-D thermal modeling for sub-0.13 μm SOI and strained-Si on SOI technologies. The thermal conductivities for thin silicon films are extracted and shown to be 4 to 10 times lower than for bulk silicon, which represents the first measured nano-scale thermal conduction effect in a real state-of-the-art semiconductor device. The impact on the performance of a high duty-cycle clock buffer circuit in a high-performance microprocessor is evaluated. [C2383]

"CNTs stabilize high temperature anatase phase of TiO_2 "

The stability of anatase phase up to 1000°C by the process of carbon nanotubes (CNTs)-hybridization is discussed in this study. The pinning effect between TiO_2 and CNTs is discovered and inhibits the nucleation of rutile phase. X-ray diffraction (XRD) and X-ray absorption near edge structure (XANES) are used to identify the phase of the nano hybrid TiO_2/CNTs material. Raman spectra were used to study the first order signals of multi-wall carbon nanotubes. The structure morphology was analyzed by transmission electron microscopy (TEM). [C2384]

"Ballistic quantum transport in nano-scale Schottky barrier tunnel transistors"

Nanoscale Schottky barrier tunnel transistors (SBTTs) are investigated by solving the two-dimensional Poisson equation self-consistently with ballistic quantum transport equations. We have analyzed the device characteristics of SBTT by varying the device parameters such as the channel length, tunnel barrier height, and gate insulator dielectric constant. We have found that on-current is almost independent of the channel length while off-current drastically increases as the channel length becomes shorter than around 15 nm. Discussions on avoiding such large off-current are presented, in terms of adjusting the Schottky barrier height and using a gate insulator with high dielectric constant. [C2385]

"Laser assisted imprint of silicon nanostructure with good crystal quality"

Excimer laser assisted imprint technology is implemented to create nanostructure on silicon substrate. Patterns with 25-nm feature sizes are successfully fabricated on quartz mold using electron beam lithography for nano-imprint. Transfer of nano-meter features to silicon is experimented. Parameters for optimal imprint are investigated. With a peak light intensity of 1–2 J/cm², imprint pressure of 10–100 g/cm², and high vacuum at 106 torr, nano-imprint has very good results. The carrier lifetimes before and after laser-assisted imprint are studied and discovered to vary from 1818 μs to 640 μs . This small damage of Si substrate is attributed to recrystallization of silicon. [C2386]

"MEMS and nano/bio technologies"

Besides rapid commercialization, MEMS is contributing to expand scientific frontiers in nano-scale and bio technology. A pair of probes with 10–50 nm tip radius were micromachined with integrated microactuators. Field emission, tunneling current and atomic transport were investigated in the gap between probes facing each other. The configuration was also applied to obtain nano tweezers that handle DNA molecules. For bio assay of enzymes, MEMS chips with fL-chambers and micro heaters were fabricated in which the enzymatic product was evaluated in a single molecular level. In addition, a conveyance device driven by bio motor molecules (microtubules and kinesin) was demonstrated. [C2387]

"A systematic approach to fabricate CNT-based nano devices: combining DEP and microspotting technologies"

An automated carbon nanotubes (CNTs) microspotting system was developed for rapid and batch assembly of bulk multi-walled carbon nanotubes (MWNT) based nanosensors. By combining dielectrophoretic (DEP) and microspotting technique, MWNT bundles were successfully and repeatably manipulated between arrays of micro-fabricated electrodes. Preliminary experimental results showed that two different spotting methods succeeded in

forming CNTs between microelectrodes and the time required to form one CNT sensor was less than 1 second. This feasible batch manufacturable method will dramatically reduce production costs and production time of nanosensing devices and potentially enable fully automated assembly of CNT based devices. [C2388]

"Cross-cultural considerations in establishing roboethics for neuro-robot applications"

Robot-user interfaces have become more intuitive as a direct consequence of the advances in computer interface design. Yet direct brain interfaces, made possible by recent advances in nano-technology and implanted cerebral electrode arrays, have the potential to eliminate these physical interfaces. However, direct brain interfaces may at the same time pose ethical questions related to the enhancement of human function through interpretation of thought processes alone. We have identified three issues that are core in the development of roboethics: how best to direct and pace the deployment and use of the technology; how to distinguish between, and perhaps as necessary redefine, what constitutes enhancement vs. functional compensation; and how to understand responsibility in a system where traditional man-machine boundaries are blurred. This paper discusses some of these issues against the backdrop of today's multi-cultural society. [C2389]

"A yield-aware modeling methodology for nano-scaled SRAM designs"

In this paper, a modeling methodology to maximize the yield of a SRAM memory array is presented. The method is robust to process variations. Calibrated models for the distributions of performance parameters are used to predict the sensitivity of the design performance to variability. The calibration and the verification of the prediction are based on 130nm devices. Projection to future nano-scaled technology nodes indicates that further scaling requires good modeling of the parametric variations to overcome poor yield, unless the variations can be better controlled. [C2390]

"Hopping growth mechanism of single carbon nanotubes synthesized by the CVD technique"

Careful preparation of iron nano-particles catalyst for carbon nanotubes (CNTs) synthesis has crucial importance for their initial growth process, what determines CNTs physical and chemical properties, such as their diameters, wall geometry, electronic structure, defects presence, etc. At present we are not able to control all factors influencing the growth of CNTs especially the geometry of the outermost shell, the numbers of shells, their external and internal diameters, the presence of different kinds of defects. Carbon offers the greatest variety of allotropic forms among all elements and it can also form one of the longest one-dimensional objects with an ordered structure and very high aspect ratio. This great structural diversity of carbon nano-objects suggests that there is great chance for their serious applications in the 21st nano-electronic century. [C2391]

"A system architecture for real-time imaging of nano-scale viruses using remote AFM"

Recent advances in telepathology, telemicroscopy, and telemedicine have opened new avenues for collaboration in medical care and scientific research. Such technology allows remote scientists and physicians to visualize and investigate biological samples in real-time. Imaging of biological specimens requires micro and even nano-scale resolution for which atomic force microscope (AFM) provides unprecedented capabilities. However, AFM has some limitations in particular, the probing hardware of AFM can introduce noise in the captured images. Robust image processing techniques are needed for accurate nano-scale representation and visualization of images generated by AFM. In this paper, we present a real-time architecture for an integrated remote AFM-based imaging system. The proposed architecture allows real-time control of a remotely located AFM and enables capturing, processing and communication of AFM images over the network. The architecture consists of four major components including, a remote AFM and real-time controller module, an image processing module for real-time image correction, a client system for visualization of scanned biological images, and a distributed image database system for information retrieval, classification, and archiving of biological specimen images received from remote AFM. [C2392]

"Local growth of carbon nanotubes on the cantilever by chemical vapor deposition with FIB assist etching"

We have controlled the local growth area of the carbon nanotubes (CNTs) on the silicon cantilever using chemical vapor deposition (CVD) with assistance of the focused ion beam (FIB) etching. By removal of the mask layer above the catalyst layer by the FIB, the CNTs were easily grown from the areas of the catalyst layer. This opens a door to the new century of the CNTs device fabrication such as, temperature sensor for the ultra small site, mass flow sensor, CNTs actuator and other various devices. [C2393]

"Towards an ubiquitous wireless digital writing instrument using MEMS motion sensing technology"

A micro inertial measurement unit (mulMU) which is based on MEMS accelerometers and gyro sensors is developed for real-time recognition of human hand motions, which when combined with appropriate filtering and transformation algorithms, becomes a digital writing system that can be used to record handwriting on any surface. The overall size of our mulMU is less than 25 mm times 70 mm times 20 mm, including the micro sensors, processor, and wireless interface components. We present our progress on using this mulMU based on Kalman filtering algorithm to filter the noise of sensors, which has allowed the system to successfully transform hand motions into recognizable and recordable English characters. Our goal is to implement this system to a digital hand-writing system that can interface with PC and mobile computing devices [C2394]

"Improvement of electrical performance of anisotropically conductive adhesives"

To improve the electrical properties of the anisotropically conductive adhesive (ACA) joints with the potential for fine pitch interconnect, self-assembled monolayer (SAM) compounds are introduced to treat nano silver (Ag) fillers. Thermogravimetric analyzer (TGA), differential scanning calorimeter (DSC), contact angle and photoacoustic Fourier transfer infrared (FTIR) results indicated the SAMs were well coated on the nano Ag particles. Furthermore, these SAM-treated ACAs were thermally stable at processing temperatures of the ACA samples. By introducing the novel SAM materials into the interfaces between nano metal fillers and the substrate bond pads, the conductivity and current carrying capability of ACAs were improved significantly due to the stronger bonding between nano fillers and SAM and consequently the improved interface properties of the high performance ACA. The improved electrical performance of nano Ag filled ACAs was accompanied with the higher thermal conductivity as well. [C2395]

"Fabrication of CNT nanosensors by combining micro-robotic spotting and DEP technologies"

An automated carbon nanotubes (CNTs) microspotting system was developed for rapid and batch assembly of bulk multi-walled carbon nanotubes (MWNT) based nanosensors. By combining dielectrophoretic (DEP) and microspotting technique, MWNT bundles were successfully and repeatably manipulated between arrays of micro-fabricated electrodes. Preliminary experimental results showed that two different spotting methods were successful in forming CNTs between microelectrodes and the time required to form one CNT sensor was less than 1 second. This feasible batch manufacturable method dramatically reduces production costs and production time of nano sensing devices and potentially enable fully automated assembly of CNT and other nanowire based devices. [C2396]

"Feasibility study on thermal survivability of X-band subsystem on RASAT microsatellite"

After the launch and commissioning of the first Turkish remote sensing satellite BILSAT-1, TUBITAK BILTEN has initiated the RASAT microsatellite project. RASAT will be a remote sensing microsatellite at low Earth orbit (LEO), with a mass of around 100 kg and an orbital average power of 38W. RASAT is planned to be launched in 2007 and will be the first satellite to be designed and manufactured entirely in Turkey. The main objective of RASAT is to perform Earth-observation using a 5- to 8-meter-resolution imager. In addition to its imaging capability, RASAT will be a platform to demonstrate current technologies using experimental payloads. Small satellites used for Earth-observation require high data transfer rates and one of the experimental payloads in RASAT is an X-Band communication subsystem intended to meet this requirement for future projects. X-band subsystem power amplifier has the overall efficiency of about 26%. Therefore, it will dissipate about 20W during data transfer and thermal issues will become important both at system and at subsystem level. As the mission analyses of RASAT have not yet been concluded, in this paper, the thermal environment and survivability of the X-Band subsystem in orbit is investigated under many uncertainties: the minimum and maximum temperatures for RASAT have been defined for LEO, the X-Band subsystem is assumed to be placed in three nano-trays and for critical nano-trays a robust thermal-mathematical model has been created for hot-case analyses. Transient and steady state temperatures of the critical components have been calculated, and the steady state temperature distribution of the PCB has been estimated. Calculations have indicated that the components on X-Band modules do not exceed upper temperature limits in RASAT and a passive thermal control method is still feasible for a system dissipating such high power. [C2397]

"Evaluating the relative effect of process variations and switching patterns on bus performance towards nano-scale interconnects"

In this paper the authors examined and compared the relative contribution between a switching pattern and process parameter variation on bus performance. The authors concentrated on interconnect parameter variation in global bus interconnects. The variation of the parameter values between individual interconnects occurs when process technologies head towards nano-scale. In addition to this "passive" process-dependent parameter variation active variation in interconnect performance due to switching data patterns in adjacent wires of a bus

structure were examined. A noise voltage in a quiet wire and the propagation delay of a signal are performance metrics in the comparisons. The effect of signal rise time is also considered. The comparisons were made using International Technology Roadmaps for Semiconductors (ITRS) from a 180-nm half-pitch node to a 22-nm node. [C2398]

"Nano-Sim: a step wise equivalent conductance based statistical simulator for nanotechnology circuit design"

New nanotechnology based devices are replacing CMOS devices to overcome CMOS technology's scaling limitations. However, many such devices exhibit nonmonotonic I-V characteristics and uncertain properties which lead to the negative differential resistance (NDR) problem and the chaotic performance. This paper proposes a new circuit simulation approach that can effectively simulate nanotechnology devices with uncertain input sources and negative differential resistance (NDR) problem. The experimental results show a 20-30 times speedup comparing with existing simulators. [C2399]

"Acquisition of direct-sequence ultra-wideband signals"

Very high rate packet data systems, such as those based on ultra-wideband (UWB) signaling, face an increasingly important challenge-achieving fast timing acquisition and synchronization (which must be done typically on an individual packet basis) to minimize preamble overhead and optimize (packet) throughput. Impulse based UWB modulation schemes use short (nano-second) time-duration pulses that are appropriately shaped-the resulting high resolution in time implies that the acquisition algorithm must employ sub-pulse duration steps, thereby leading to a large search space if a serial timing acquisition approach is used. Moreover, owing to the strict average transmit power limitations on UWB transmissions resulting from the Part 15 limits imposed by the FCC, a large number of pulses need to be integrated for reliable acquisition decisions, which consequently leads to large mean acquisition times (MAT). We investigate the performance of the conventional serial search and random search schemes applied to the acquisition of UWB signals in multipath environments. It is shown that over typical UWB multipath channels, a random search scheme may yield lower MAT than serial search. [C2400]

"Exploring technology alternatives for nano-scale FPGA interconnects"

Field programmable gate arrays (FPGAs) are becoming increasingly popular. With their regular structures, they are particularly amenable to scaling to smaller technologies. On the other hand, there have been significant advances in nano-electronics fabrication over the past few years. In this paper we explore FPGA devices of the next decade using nano-wires and molecular switches for programmable interconnect, and compare them to traditional SRAM-based FPGAs that use pass transistors as switches (scaled to 22nm). We show that by using nano-wires and molecular switches, it is possible to reduce the area of the FPGA by 70% and improve performance. [C2401]

"Determining optimum and suboptimum disassembly sequences with an application to a cell phone"

We study the disassembly process of a moderately complex consumer product (cell phone) consisting of 25 components. The investigation involves a heuristically solved disassembly line balancing problem and the determination of an appropriate disassembly sequence influenced by sequence-dependent costs, which is based on a novel combination of exact and heuristic algorithms. The issue of generating various suboptimum solutions to cope with multiple optimization criteria is also discussed [C2402]

"Unified parasitic de-embedding methodology of on-wafer multi-port device characterization"

Systematic de-embedding methodology is proposed for on-wafer characterization of multi-port devices in the RF/microwave regime. This approach incorporates the shield-based measurement technique with the concept of scalable interconnect parameters from transmission-line theory. By grounding the metal shield, the port-to-port coupling and substrate leakage can be substantially mitigated and thus the de-embedding procedure can be simplified. We introduce the open and through dummy structures to eliminate the parasitics associated with the probe pads and interconnects. The four-port spiral transformer and its corresponding dummies were characterized up to 20 GHz, and the influences of the de-embedding accuracy on device characteristics were also demonstrated. [C2403]

"Silicon-on-insulator based nano-photonics: Why, How, What for?"

Silicon-on-insulator is rapidly emerging as a versatile platform for a variety of integrated nano-photonic

components. This paper discusses the variety of merits offered by this system. The key technological challenges are discussed as well as the potential in multiple application fields. [C2404]

"Optimized Nickel Silicide Technology for Fully Depleted Nano-Scale SIO MOSFETs"

Optimized nickel silicide technology is proposed for high performance fully depleted nano-scale SOI CMOSFETs. Nickel silicide properties with different initial nickel thicknesses were investigated on thin film SOI MOSFETs. Silicon consumption rate and correlation between the deposited nickel and the formed nickel silicide thickness were calculated. It was shown that more thermally stable nickel silicide was formed with the controlled nickel thickness. Moreover, enhanced device performance of fully depleted SOI NMOSFET was demonstrated with the controlled nickel thickness [C2405]

"Development of the HAUSAT-2 nanosatellite for low-cost technology demonstration"

This paper addresses the development and design of the HAUSAT-2 (Hankuk Aviation University SATellite-2) which is nano class ultra-small satellite, being developed by SSRL (Space System Research Lab.) of Hankuk Aviation University. As a spin-off result, the HAUSAT-2 project can offer graduate and undergraduate students great opportunities to be able to understand the satellite design process, analysis, manufacturing, assembly, integration, test, launch and operation and also provides practical experience as a team member. The main mission objectives of the HAUSAT-2 satellite are to study the scope of activities and ecology of animals using Animal Tracking System (ATS) and collect the space information data from Electric Plasma Probe (EPP) as a space science payload. The HAUSAT-2 satellite is being designed to be compatible with a LEO with attitude 650 800 km sun synchronous orbit during design mission life which is expected to be 2 years. The HAUSAT-2 is a nano-satellite which is less than 25kg of mass with 30 cm Ч 30 cm Ч 38 cm hexahedron configuration. The three-axis stabilization is being implemented with pitch bias momentum method. Sun sensors and magnetometer manufactured by SSRL will provide attitude. [C2406]

"First investigations on force mechanisms in liquid solidification micro-gripping"

The paper reports on ongoing research on liquid solidification based micro-gripping. First, micro-grip technology and the features of liquid solidification gripping are introduced. Next, the physical mechanisms of adhesion in terms of the role they play in solidification gripping are described. A research prototype design and first experimental results, focused on the grip force that can be generated, are then reported on. It is shown that the main parameters which influence the grip force are the surface roughness of the part, the material combinations and freezing temperature. Forces are measured in the range of 0.6 up to 5.3 N with a contact area of about 1 to 2 mm² [C2407]

"Inverse offset of Z-map model for process planning assistance"

Inverse offsetting is a special type of Minkowski sum operation with a solid model and an inversed shape of a milling cutter. In the NC machining, geometric simulations of the milling operation are often performed prior to the actual machining to visualize the result shape of the workpiece. Inverse offsetting of this workpiece shape is useful for automating some process planning tasks, especially a task for determining milling regions for the following machining operations. Most milling simulation programs use discrete Z-map models for representing the workpiece shape. In this paper, an algorithm for inverse offsetting the Z-map model is proposed. Our algorithm computes dense zig-zag curves covering the Z-map model, then it generates the swept volume of the inversed cutter moving along the curves to obtain the inverse offset shape of the model. The proposed algorithm is implemented and an experimental process planning assistance program using this technology is demonstrated [C2408]

"Safety and security technology in life space with IRT service network"

Robots are required to work instead of human. A dangerous task in extreme situation, complicated routine work and so on, are estimated. As one of them, information service for security and safety using Internet are expected. Furthermore, information and robot services bring us more suitable environment. It's called as IRT (information technology and robot technology). In this paper, we describe what IRT bring us for security and safety service, and requirements for robot system in order to realize IRT service system. [C2409]

"Realization of an adaptive modular control for a disassembly system"

At the Institute for Machine Tools and Factory Management (IWF) an adaptive modular control for a pilot disassembly, which increases the reliability and efficiency of a disassembly plant system was realized. The previous research activities for the generation of operating sequences of disassembly processes were extended

by the examination of the availabilities of disassembly facilities and the technical feasibilities of disassembly procedures. The exemplary implementation of the concept of the adaptive modular control is presented on the disassembly step "destructive disassembly of a washing machine side panel". Also the adjustment of the soft- and hardware components of the pilot disassembly system is discussed, whereby the connection of the IT components and the adjustment of the software details is introduced. For the realization of the adaptive control necessary adjustments were made. The programs of the programmable logic control and the robot were customized. The interface technologies are relevant factors. Beyond that the linkage of the IT-components forms the basis of the modular adaptive control [C2410]

"Microstructure and magnetic properties of granular nanocomposite FePt/Ag multilayer films"

FePt magnetic layer and Ag top layer are deposited subsequently onto the MgO underlayer and annealed at 400°C for 30 min. It is found that a large H_c value of about 3923 Oe with nano-grain of about 8 nm can be obtained after annealing at 400 °C, and that the H_c value of the MgO/FePt/Ag films increases with increasing annealing temperature. After TEM-EDS analysis of the multilayer films, it is found that Ag mainly distributed at the grain boundary of FePt that resulted in the increase of the grain boundary energy, enhancing the coercivity and changing the preferred orientation of FePt film. [C2411]

"Nanoimprint technology and applications"

Summary form only given. The discrete track and patterned medias are candidates for higher density storage. The principal of read/write abilities has been reported. The production methods for these medias are under investigated. Nanoimprint technology is one of the attractive methods for ultra-fine patterning. The principle of nanoimprint is press molding in nano-scale. There are several points for the industrial applications such as resolution, pattern formation area, precise control of pattern transfer, lifetime of nano-mold, alignment and so on. The resolution of 6 nm half pitch was confirmed using super-lattice nano-mold (M. D. Austin, et al., 2004), and this resolution is good enough for future IT devices. Pattern formation area is also important for device production. The pattern formation on 300 mm diameter wafer was reported (M. Ogino, et al., 2004) by thermal nanoimprint process. Nanoimprint technology is spreading to not only IT/electronic devices but also bio and energy devices. It will be important that choosing the suitable technology for media application among the common nanoimprint technology. [C2412]

"Gate effect on Hall voltage in a InSb/FM device"

A gate controlled Hall effect device was fabricated, in which a ferromagnetic element was deposited on top of insulated InSb Hall cross. It was shown that the magnetic fringe fields from a ferromagnet can effectively generate Hall voltage and create hysteresis in the Hall resistance. The Hall voltage was amplified by applying gate voltage. The increase was due to the reduction of carrier density induced by the gate confinement effect. [C2413]

"Silicon based spin valve device"

The spin injection and transport properties of the Permalloy/Si/Permalloy (Py) hybrid device fabricated on 50 nm thick silicon film on insulator (SOI) wafer were investigated in this study. Spin valve effect was found in the field range of 100–200 Oe over which magnetization of two Py is aligned antiparallel showing maximum resistance. The result indicates that the spin polarized electrons are injected and are detected after transporting through Si channel on insulator. [C2414]

"Nanocircuit elements, nano-transmission lines and nano-antennas using plasmonic materials in the optical domain"

Optical wave interaction with metallic nanoparticles is one of the interesting problems in nanotechnology and nanophotonics. For certain noble metals, the plasma frequency is in the visible or ultraviolet wavelengths, and therefore their permittivity have negative real parts in the optical frequencies. These metals behave as plasmonic materials, and as a result, their interaction with optical signals involves surface plasmon resonances. Using such plasmonic materials as nanocircuit elements, this paper describes a nano-transmission line provide a guided-wave structure in the optical regime with a lateral cross section far less than the operating wavelength, analogous to the conventional transmission line in the microwave regime. Nano-antennas, which are nanometer-sized transmitting and receiving systems, are also discussed. [C2415]

"Mechanical characteristics of FIB deposited carbon nanowire by electrostatic actuated nano tensile testing devices (EANAT)"

This research develops Electrostatic Actuated NANO Tensile testing devices, which are named "EANAT" from the initial letter, in order to reveal mechanical properties of carbon nanowires deposited by focused ion beam assisted chemical vapor deposition (FIB-CVD). Nanometric carbon structures deposited by FIB-CVD are one of promising nanomaterials used for NEMS. In this research, mechanical properties of 85 nm-diametric carbon nanowires were evaluated using three types of EANAT containing electrostatic comb drive actuators from 1000 to 5000 pairs. Young's modulus of carbon nanowires averaged 80 GPa, which is close to reported values of ultra-thin diamond-like carbon films. The tensile strength of nanowires was also 6 GPa in average. [C2416]

"Magnetization reversal by spin polarized current in nano-pillars with a synthetic antiferromagnet free layer"

Spin transfer magnetization switching is studied in nano-pillars with a synthetic antiferromagnetic free layer (SyAF), CoFe/Ru/CoFe, under an external magnetic field. The resistance change for the conventional type nano-pillar (CoFe) and SyAF type sample is almost the same, demonstrating full reversal of the magnetization. On the other hand, the critical current as a function of magnetic field for the SyAF type is found to behave in the opposite way with that of the conventional type. [C2417]

"Small diameter nano- and micro-wire tapers in single mode fibre"

Prompted by the recent interest in nano-wires, this paper reports on the successful production of very small diameter (sub-micron), low-loss tapers in single mode fibre. This approach gives a convenient single mode launch into the tapered waveguide or micro-wire and conserves the single mode throughout the structure. Results from couplers fabricated by twisting two such structures together and other related phenomena are reported. [C2418]

"MR enhancement of CPP-GMR by CCP-NOL spacer and Fe50 Co50 magnetic layers"

This paper reports that further increase of magnetoresistance (MR) ratio to 6.5–8.5% is achieved by using Fe50Co50 magnetic layers, in addition to current-confined-path (CCP)-nanooxide layer (NOL). The CCP-CPP structure is composed of Ta/Ru/PtMn/Co90Fe10/Ru/pinned layer/NOL spacer/free layer/Cu/Ta cap. Using Fe50Co50/Cu as pinned and free layers, an MR ratio of 6.5–8.5% is obtained at area resistance (RA)=300–1000 mΩμm² and if Co90Fe10 is used, MR ratio of 3–4% is shown at RA=300 mΩμm². The increase of MR ratio is explained by increase of spin dependent scattering at the interface of Fe50Co50 and Cu metal path where current is concentrated. Conduction examination shows that there is a resistance increase caused by joule heating effect with increasing voltage, indicating that great majority of current flows in metal paths. The origin of MR comes from nano-constricted metal path regions which dimension is less than the mean free path of electron. [C2419]

"Towards an implantable ultra-low power biochemical signal processor for blood and tissue monitoring"

On-line, real time, physiological monitoring of blood and tissue requires ultra-low power biosensor technology. In this paper, we present the first reported results of the use of an ion sensitive field effect transistor (ISFET), operating in sub-threshold (weak inversion) to achieve nano-power biosensor performance. Measured data from a pilot study on blood samples using ISFET-based sensors biased in their weak inversion regions to measure ion and metabolite concentration is presented. Building blocks for the creation of low-power biochemical sensors with local processing are proposed. These include current-mode processing blocks such as translinear circuits as well as a form of "biochemical" logic. This paper demonstrates an important and necessary step towards biochemical VLSI. [C2420]

"Tunnel magnetoresistance enhancement in ferromagnetic tunnel junctions with ferromagnetic nano-particle layer insertion"

Coulomb blockade dominates the electron transport in an ultra-small double tunnel junction. Here, a helicon sputtering deposition system is used to fabricate Co90Fe10/AlOx/Co90Fe10/AlOx/Co90Fe10 MDTJs. The enhancement of TMR ratio within the Coulomb blockade regime. TMR curves across the MDTJs show a superparamagnetic behavior. It was also observed that the bias voltage dependence of the TMR becomes broader above 50 K, and the enhancement of the TMR around zero bias disappears at room temperature. [C2421]

"Reversible fault-tolerant logic"

It is now widely accepted that the CMOS technology implementing irreversible logic may hit a scaling limit

beyond 2016, and that the increased power dissipation is a major limiting factor. Reversible computing can potentially require arbitrarily small amounts of energy. Recently several nano-scale devices which have the potential to scale, and which naturally perform reversible logic, have emerged. This paper addresses several fundamental issues that need to be addressed before any nano-scale reversible computing systems can be realized, including reliability and performance trade-offs and architecture optimization. Many nano-scale devices are limited to only near neighbor interactions, requiring careful optimization of circuits. We provide efficient fault-tolerant (FT) circuits when restricted to both 2D and 1D. Finally, we compute bounds on the entropy (and hence, heat) generated by our FT circuits and provide quantitative estimates on how large can we make our circuits before we lose any advantage over irreversible computing. [C2422]

"Who is responsible for the design for manufacturability issues in the era of nano-technologies? [CPanel I]"

{no data available} [C2423]

"Development of NanoCAP (nano composite advanced particles) technology for high density recording"

In this paper, nanosized spherical magnetite particles, with the coercivity force of about 3000 Oe was developed. This material was named NanoCAP (nano composite advanced particles). This study described both magnetic and structural properties of NanoCAP. The crystal structure and the microstructure of the particles were examined using an X-ray diffractometer and high resolution transmission electron microscope, respectively. The obtained magnetization and coercivity of the particles were 89 emu/g and 2900 Oe, respectively. NanoCAP is expected to be the most promising candidate for ultrahigh capacity recording tapes. [C2424]

"Breakdown behavior of current perpendicular to the plane devices with nano-oxide current screening layers"

The resistance R and magneto-resistance (dR/R) changes of current perpendicular to the plane (CPP) pillars with nano-oxide current screening layers under constant voltage stress are measured. The pillars, with diameter ranging from 50 nm to 4 μm , are antiparallel pinned PtMn spin-valves and the CoFe nano-oxide layer is located in the Cu spacer layer. Results show that an irreversible damage occurs at 170 mV and at this voltage, both the resistance and magneto-resistance decrease. This indicates that pinhole formation and growth in the nano-oxide layer is responsible for the breakdown. As device sizes decrease, breakdown voltages increase from 40 mV up to 170 mV. This indicates that pinhole formation follows a weakest link model for the larger devices and is induced by reaching a critical current density (voltage) for the smaller devices. [C2425]

"Switching of magnetostrictive micro-dot arrays by mechanical strain"

CoFeBSi and FeCo magnetostrictive micro-and nano-dot arrays are fabricated on Si₃N₄ membranes with different diameters (50 to 300 μm) by combining MEMS fabrication processes and thin film technology. Compressive or tensile mechanical strain is introduced in order to observe the inverse magnetostriction effect or the Villari effect. Magnetic force microscopy and MOKE measurements are employed in order to investigate the strain induced switching properties and resolve the domain structure of the amorphous micro- and nano-dot arrays. The local strain distribution of the various membrane structures is obtained by finite-element method. The results of the simulations are then compared to the experimental results. [C2426]

"Oblique ion nano-texturing technology for longitudinal recording media"

The surface morphology induced by oblique ion beam etching (IBE) technique and the magnetic properties (radial and circumferential coercivity) of the fabricated surface were reported in this paper. A novel texturing technology using IBE for ultra-high-density longitudinal recording media was also proposed. The media structure is composed of the glass substrate and an amorphous seed layer, RuAl seed layer, Cr-Mo underlayer, Co-Cr intermediate layer, Co-Cr-Pt-B magnetic layer and C protective layer. [C2427]

"Proposal of new type of micro-machined quartz tuning fork AFM probe"

A quartz probe structure with a monolithically integrated tuning fork with a sharp tip at the end has been developed for application to noncontact atomic force microscopy (AFM) systems. The structure is fabricated using quartz micromachining technologies. Evaluation of the properties of a fabricated quartz tuning fork showed that it had a Q-factor of 2348, a resonant frequency of 39.92 kHz, and amplitude of 2.69 μm . It would thus have atomic-level resolution in an AFM system. [C2428]

"Nano-Composite Lead-Free Interconnect and Reliability"

First Page of the Article [\[C2429\]](#)

"Array of Nano-Cantilevers as a Bio-Assay for Cancer Diagnosis"

First Page of the Article [\[C2430\]](#)

"Molecular dynamics simulation of lead free solder for low temperature reflow applications"

The modified embedded atom method (MEAM) was employed in conjunction with molecular dynamics (MD) simulations to investigate whether a physical mixture of nano Sn and nano Ag particles at a prescribed ratio would achieve the same intermixing as a nano Sn/Ag alloy. A Sn sphere and a Ag sphere both with a diameter of 4 nm were prepared by cutting the perfect bulk lattice structure. After energy minimization and structural relaxation, the two spheres were placed next to each other with a gap of 3 E. The simulation was then performed at 500 K for 3000 ps. Simulation results showed that nano Ag sphere still maintained its crystalline structure and no significant diffusion between Sn and Ag was observed. Based on the time frame involved in simulation (3 ns), the results implied that a physical mixture of nano Sn and nano Ag particles may not suffice the requirements of lead free solder for low temperature reflow applications. [\[C2431\]](#)

"Experimental damage mechanics of microelectronic solder joints under fatigue loading"

Fatigue damage is a progressive process of material degradation. The objective of this study is to experimentally qualify the damage mechanism in solder joints in electronic packaging under thermal fatigue loading. Another objective of this paper is to show that damage mechanism under thermal cycling and mechanical cycling is very different. Elastic modulus degradation under thermal cycling, which is considered as a physically detectable quantity of material degradation, was measured by nano-indenter. It was compared with tendency of inelastic strain accumulation of solder joints in ball grid array (BGA) package under thermal cycling, which was measured by Moire interferometry. Fatigue damage evolution in solder joints with traditional load-drop criterion was also investigated by shear-strain hysteresis loops from strain-controlled cyclic shear testing of thin layer solder joints. Load-drop behavior was compared with elastic modulus degradation of solder joints under thermal cycling. Following conventional Coffin-Manson approach, S-N curve was obtained from isothermal fatigue testing with load-drop criterion. Coffin-Manson curves obtained from strain controlled mechanical tests were used to predict fatigue life of solder joints. In this paper it is shown that this approach underestimates the fatigue life by an order of magnitude. Results obtained in this project indicate that thermal fatigue and isothermal mechanical fatigue are completely different damage mechanism for microstructurally evolving materials. [\[C2432\]](#)

"Development of nanocomposite lead-free electronic solders"

Inert, hybrid inorganic/organic, nano-structured chemicals, can be incorporated into low melting metallic materials, such as lead-free electronic solders to achieve desired level of performance. The nano-structured materials technology of polyhedral oligomeric silsesquioxanes (POSS), with appropriate organic groups, can produce suitable means to promote bonding between nano-reinforcements and the metallic matrix. The microstructures of lead-free solder with surface-active POSS tri-silanols were evaluated using scanning electron microscopy (SEM). Wettability of POSS-containing lead-free solders to copper substrate was also examined. Steady-state deformation of solder joints made of eutectic Sn-Ag solder with varying weight fraction of POSS of different chemical moieties were evaluated at a range of temperatures (25°C, 100°C, and 150°C) using a Rheometric Solids Analyzer (RSA-III). Mechanical properties such as shear stress versus simple shear-strain relationships, peak shear stress as a function of rate of simple shear-strain and testing temperature were reported. The service reliability of joints made with these newly formulated nanocomposite solders was evaluated using a realistic thermomechanical fatigue (TMF) profile. Evolution of microstructures and residual mechanical property at different extend of TMF cycles were compared with joints made of standard, un-reinforced eutectic Sn-Ag solder. [\[C2433\]](#)

"New nano-particle material (NPM) for micro- and opto-electronic packaging applications"

A new advanced nano-particle material (NPM) has been developed by the SBIR ERS/Siloptix Co. This material has many attractive applications in micro- and opto-electronic packaging. Particularly, an effective practical technology for making NPM-based optical silica fiber coatings has been developed under grants from DARPA/Navy. The developed technology enables one to create ultra-thin, highly cost-effective, highly mechanically reliable, and highly environmentally durable coatings for silica light-guides. The obtained results have demonstrated the performance superiority of the developed technology over polymer-coated and metallized fibers, as well as a potential that the NPM has for various commercial and military applications in micro- and

opto-electronics packaging and beyond. [C2434]

"Nano-Underfills for High-Reliability Applications in Extreme Environments"

First Page of the Article [C2435]

"Flexible circuit creation with nano metal particles"

Low cost and reliable printing technologies are more and more attractive to flexible electronic industries for replacing traditional subtractive etched Cu in circuit creations. In this paper, nano metal particle (NMP) Ag traces are compared with conductive lithograph film (CLF) Ag, thick film (TF) Ag, TF Cu traces, and traditional etched (etched) Cu with regard to trace resolution, surface quality, microstructure, and electrical conductivity. The results show that, next to etched Cu, the NMP Ag traces have the smoothest surface, highest resolution, densest structure, and highest conductivity. The advantages and disadvantages of NMP Ag traces are discussed from the perspective of metallurgical process of sintering and microstructure. Suggestions are given for further improvement of the nano metal particle circuitry technology. [C2436]

"50 Micron Pitch Wafer Level Packaging Testbed with Reworkable IC-Package Nano Interconnects"

First Page of the Article [C2437]

"Dielectric behavior of ultrahigh-k carbon black composites for embedded capacitor applications"

Polymer based nanocomposites have been of great interest as embedded capacitor dielectrics because of their low cost and excellent compatibility with the organic substrate manufacturing processes. One of the polymer nanocomposites that have been studied is the carbon black/polymer composite, which could give a high dielectric constant over 1,000. In this paper, the dielectric behavior of carbon black CBCA6/epoxy composite was systematically investigated and analyzed. It was found that this composite consistently showed a high dielectric constant of over 1,000 at the proper filler loading levels, however, the dissipation factor of this carbon black composite was high ($\tan\delta > 1$). Moreover, frequency dependence of the dielectric constant and dielectric loss were observed in the middle frequency range up to 10 MHz. Carbon black is a nano structured material which has a large surface area and a wide range of electrical properties based on its surface chemistry, particle size and aggregate structure, and the polymer-carbon black interfaces are believed to contribute significantly to the high loss and high frequency dependence. Therefore, fundamental studies of the interface and its modification with additives were conducted in this research in order to obtain low-loss ultrahigh-k carbon black composites. A high breakdown field inorganic filler, i.e. fumed silica, was included to the carbon black-polymer formulation in order to modify the carbon black-polymer interfaces and reduce the high conduction dielectric losses of carbon black composites. It was found that the dielectric loss of carbon black composites decreased with the fumed silica inclusion. The fumed silica was also found to significantly change the frequency dependence behavior of carbon black composites. [C2438]

"Demonstration for rapid prototyping of micro-systems packaging by data-driven chip-first process using nano-particles metal colloids"

In order to reduce process complexity, manufacturing cost and lead time, while enhancing electrical and mechanical reliability performance, a new innovative approach, which specifically targeted to prototype and low volume production in microsystems packaging and system in package, is being developed. The approach is rapid prototyping of microsystems packaging by data driven chip-first packaging process using nanoparticle metal colloids. According to the concept of the chip-first process, bare dice and standard passive components are first embedded into a carrier substrate to achieve a common, planar surface. On the planar substrate, polyimide film is laminated to make a dielectric layer. Over the dielectric layers and chip metal pads, silver nanoparticles, which has high conductivity and good adhesion to copper, polyimide, benzocyclobutene (BCB) and liquid crystal polymer (LCP), are deposited by screen printing, forming a three dimensional electrical circuit. This approach is data-driven so that it requires no photo masks and reduces turnaround time and is also less limited by substrate composition and morphology. This approach also eliminates the need for special chip processing such as the need required for flip chip solder bumps and permits using any chip technology and any chip supplier allowing mixed devices. In addition, the data-driven process with metallic nanoparticle avoids the extreme processing conditions required for standard IC fabrication such as wet chemistry processing and vacuum sputtering. Nanoparticles typically measure around 5nm in diameter and can be sintered at plastic-compatible temperatures as low as 220C to form material nearly indistinguishable from the bulk material. These results represent an important step to a system packaging characterized by high density, low cost, and data-driven fabrication for

rapid turn-around time. [C2439]

"Mechano-biochemistry"

The emergence of microfabricated cantilever sensors, which can directly translate molecular recognition binding events into a nanomechanical response, offers a highly sensitive method to detect chemical and biological molecules. This novel nano-mechanical actuation mechanism has important advantages because it requires no sample labelling and so analytes can be detected in a single step reaction. Furthermore these miniaturised sensors are highly suitable for parallelization into integrated, portable devices and the first microarray of levers for multiple DNA detection has recently been demonstrated. The goal of our research is to explore the versatility of this new sensing mechanism, probing systems of growing complexity; from small molecule binding interactions, through to DNA, protein and cancer cell studies. Central to this work is the delicate interplay between surface chemistry and mechanics and current efforts are focused on developing a fundamental understanding of surface stress at the solid-liquid interface. Novel surface chemistries and polymer coatings are being explored in order to enhance the surface stress signal. Also different cantilever geometries, material properties, actuation and detection methods will be discussed. [C2440]

"Developing a course about nano-packaging"

This paper describes the students' education in electronics packaging at Dresden University of Technology, Germany. Beginning with a summary about the general model and the existing lectures it is shown, how step by step the knowledge about the topics of producing electronic modules is improved and also combined with practical experiences and skills. Following this a brief section shows the recent developments in packaging. This leads to the necessity to enhance the courses contents to these leading-edge developments to well the students up for their upcoming business. Finally the concept of a course offered for graduate students and dealing with topics around nano-packaging is introduced. [C2441]

"Exploring the limits of low cost, organics-compatible high-k ceramic thin films for embedded decoupling applications"

This paper presents four organic-compatible thin film processing techniques for embedding capacitors into organic PWBs. Hydrothermal synthesis allows integration of pure nano-grained barium titanate films with capacitance density of about 1 $\mu\text{F}/\text{cm}^2$. Sol-gel and RF-sputtering in conjunction with a foil transfer process can be used to integrate a variety of perovskite thin films with the capacitance in the range of 200-400 nF/cm². Thermal oxidation of titanium foil also emerges as a viable process for integrating capacitance of 100s of nF using a foil transfer process. The dielectric properties of the films synthesized by these techniques as a function of various process parameters are presented. Observed dielectric properties like dielectric constant, leakage current and breakdown strengths have been correlated to structural defects and stoichiometry of the films. [C2442]

"Nano-Ag Filled Anisotropic Conductive Adhesives (ACA) with Self-Assembled Monolayer and Sintering Behavior for High"

Recently, anisotropic conductive adhesives (ACAs) have attracted increasing interests in electronic packaging industry due to the advantages of ultra fine pitch capability potential (pitch <20 μm due to the availability of micro-sized conductive particles), low processing temperatures, low stress on substrate, environmentally friendly, etc. In this study, effects of nano silver (Ag) particles on electrical properties of ACA formulations were investigated. The nano Ag particles exhibited sintering behavior at significantly lower temperatures (<200degC) than the melting point (T_m of Ag is 960degC). The sintered nano Ag particles significantly reduced the ACA joint resistance and enhanced the current carrying capability of ACAs. The reasons for the enhanced performance of ACA were attributed to the increased contact area and improved interfacial contact between nano Ag and bond pads by sintering and compressing processes of the ACA. In addition, different types of self-assembled monolayers (SAMs) were used to treat nano Ag fillers. Thermogravimetric analyzer (TGA), differential scanning calorimeter (DSC), contact angle and photoacoustic Fourier Transfer Infrared (FTIR) results indicated the SAMs were well coated on the nano Ag particles. Furthermore, these SAM-treated ACAs were thermally stable at processing temperatures of the ACA samples. By introducing the novel SAM materials into the interfaces between nano metal fillers and the substrate bond pads, the conductivity and current carrying capability of ACAs were further improved due to the stronger bonding between nano fillers and SAM and consequently the improved interface properties of the high performance ACA for potential microprocessor applications [C2443]

"Lotus effect surface for prevention of microelectromechanical system (MEMS) stiction"

Due to the surface smoothness of micromachined structures, strong adhesion forces between these fabricated structures and the substrate can be developed. Once contact is made, the magnitude of these forces is sufficient to deform and attract these structures to the substrate, resulting in device failure. This type of failure is one of the dominant sources of yield loss in microelectromechanical system (MEMS) fabrications. The basic approaches to prevent stiction include increasing surface roughness and/or lowering solid surface energy by coating with low surface energy materials. By nature, the Lotus Effect surface is an excellent model surface of a combined effect of hydrophobicity and micro/nano scale structure topography. Such surfaces have water droplet contact angles of 150° or higher. The intrinsically superhydrophobic surfaces can avoid an attractive capillary force which pulls the MEMS microstructure to the substrate; as such they reduce van der Waals forces as well. To prepare a lotus effect surface, aligned carbon nanotubes (ACNTs) that are perpendicular to the substrate surface are created. The nanotubes were grown in a chemical vapor deposition (CVD) tube furnace system from a vapor-phase mixture of xylene and ferrocene. The ferrocene was the nucleation initiator and xylene as the carbon source. Multiwalled carbon nanotubes of 20-30 nm in diameter were fabricated onto SiO₂ surfaces that were deposited by the plasma enhanced chemical vapor deposition (PECVD) method. The average center-to-center spacing (pitch) between adjacent nanotubes was 50 nm. The as-grown vertical nanotubes showed good adhesion to the substrate, which made the nano-scaled roughness possible. The initial water contact angle on the as-grown aligned CNT surface was 155°. To improve the stability of the superhydrophobic surface, the aligned CNTs were modified by fluorinated polymers formed by PECVD. The as-grown CNTs were characterized using scanning electron microscopy (SEM) and high resolution transmission electron microscopy (HRTEM). [C2444]

"Material characterization for nano wafer level packaging application"

As the feature size of integrated circuit (IC) packages needs to be decreased significantly, computational methods in conjunction with experimental data have been employed to study the mechanical issues, which have become a concern for the components reliability. In this paper, the issues associated with and experimental methods necessary to perform material characterization for nano-wafer level packaging application will be investigated. Firstly, the need for nano-indentation to accurately characterize the modulus and hardness of copper thin film will be presented. Furthermore, some of the problems such as strain rate and thickness effects associated with extracting the modulus using nano-indentation will be addressed. Lastly, results from a fatigue experiment on a 200 µm pitch solder column will also be given and factors affecting the failure criterion of these solder columns in fatigue conditions will be investigated. [C2445]

"Nano-net fabrication on the glass capillary by focused-ion-beam chemical-vapor-deposition"

Nano-tools are very important for the subcellular operation and analysis in the bio-experiments. For giving the high-performance to nano-tool, we think that it is necessary to make tools the three-dimensional (3D) nano-structure devices. Therefore, we have performed the 3D nano-tools fabrication by using focused-ion-beam chemical-vapor-deposition (FIB-CVD). This time, a nano-net as a novel 3D nano-tool was fabricated by using FIB-CVD. And we succeeded in scooping the polystyrene micro-sphere with a diameter of 2.0 µm by using a nano-net. [C2446]

"Densely arrayed microneedles having flow channel fabricated by mechanical dicing and anisotropic wet etching of silicon"

We previously proposed a novel process combining mechanical dicing and anisotropic wet etching for fabricating arrayed MEMS structures, and used it to make solid-type microneedle structures in drug delivery systems (Shikida et al., 2004). For this report, we further developed the fabrication process for embedding two types of flow channels in our microneedle structures. One type has a channel with an opening at the base of each needle, and the other type has a cored channel in the needle. The height and pitch of the needles were 120-550 µm and 230-370 µm, respectively. The new process does not include the expensive deep RIE process, and is applicable to disposable injection and extraction needles used in bio-medical applications. [C2447]

"An error detection and correction scheme for RAMs with partial-write function"

With the nano-scale VLSI technology and system-on-chip (SOC) design methodology, the reliability has become one major challenge in SOC. Especially, embedded memory cores heavily impact on the reliability of SOC. Error detection and correction (EDAC) techniques are well-known methodologies for detecting and correcting soft errors of random access memories. However, conventional EDAC techniques cannot effectively be applied to embedded memory cores with partial-write operation. This paper presents an EDAC scheme for embedded memory cores with partial-write operation. The area cost for implementing the proposed EDAC scheme in an 8K 1Ч 64-bit SRAM core with half-word parity (i.e., two parity bits for each word) is about 21% based on 0.18µm TSMC standard cells. [C2448]

"Fatigue study of nano-scale silicon nitride thin films using a novel electrostatic actuator"

We report for the first time the fatigue study of nanoscale silicon nitride (SiN) thin films using a novel electrostatic actuator. The mechanical-amplifier (MA) devices made in SiN thin films can apply controllable tensile stress (2.0-7.8 GPa) to test structures with relatively low actuation voltages (5.7-35.4 VRMS) at their resonant frequencies. With the recently developed experimental techniques inside a focused-ion-beam (FIB) system, in-situ fatigue measurements are performed on SiN test structures with a linewidth of 200 nm. The SiN test structures are found to exhibit time-delayed failures with a continuous increase in their compliance. By reducing the applied tensile stress to 3.8 GPa, the test structures can survive cyclic loadings up to 10 cycles.

[C2449]

"Characteristics of modified-Schottky-barrier (MSB) FinFETs"

It has been reported that modified-Schottky-barrier (MSB) FinFET can solve the problem of low on-state/off-state current ratio that the conventional SB MOSFETs have. In this work, we report for the first time that high performance n- and p-channel MSB devices can be fabricated with the same metal silicide and process technique. Detailed device characteristics as well as hot carrier reliability of MSB FinFETs are investigated. It is concluded that the high performance MSB FinFET is also highly reliable. The simple process and low thermal budget features make the MSB FinFET a very promising nano device. [C2450]

"Future of the MOS transistor in the nano-electronics era"

Operational MOS transistors shorter than 10nm have been demonstrated at recent CMOS conferences. Yes, but their electrical characteristics remain by far behind the specifications (ITRS Roadmap). Does it mean that scaling is dead? Does it mean that the future of the Moore's laws is menaced? We analyze these questions in detail and identify the physical causes behind the prospective CMOS performance deficiency. To illustrate the point, we show an anomalous scaling effect leading to a decrease in the transistor current when its channel is being shortened (a completely inverse effect with respect to the classical scaling). In the second part of the paper, we show how non-classical device structures: ultra thin single- and double-gate devices such as SOI, FinFET, SON (silicon on nothing) and new materials (HK-dielectrics, metallic gates, strained-Si) can help with retrieving healthy scaling. We also deliberate on how they can help to overcome or at least attenuate the problems with short-channel effect, with drain-induced barrier lowering effects, with high-field effects, with mobility degradation, with subthreshold leakage and finally with quantum effects, with discreteness of the matter etc., etc. In order to become reality, this huge potential of non-classical CMOS requires process availability and optimization based on a good understanding of the physics of these devices. We analyze the latter in terms of optimal silicon film thickness, optimal BOX thickness, ground-plane operation, optimal channel doping, threshold voltage adjustment with metallic gates and HK dielectrics, etc. etc. Finally, we show how these new device structures and materials prolongs the Moore's laws up to the end of the roadmap (example of HP non-classical CMOS is also shown), and even beyond, thereby projecting CMOS into the nano-world. [C2451]

"Post-CMOS process for high-aspect-ratio monolithically integrated single crystal silicon microstructures"

A novel modular fabrication process for bulk integrated single-crystal-silicon microstructures designed and manufactured in a post-CMOS process is presented in this paper, which can increase the accuracy and reliability of MEMS sensors as well as lower the fabricating cost. The process involves the conventional CMOS circuit formation, the electrical isolation trench etching and refilling, backside silicon etching, interconnection formation, and structure releasing. The performance of integrated Schottky diodes was tested to have reverse leakage of 10-7A, and breakdown voltage of 57V. A new method for fabricating void-free isolation trenches is also developed. The resistance of void-free isolation trench is more than 1012Ω. The influence of LPCVD high temperature on the doping distribution is simulated. [C2452]

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{no data available} [C2453]

"45 nm-node BEOL integration featuring porous-ultra-low-k/Cu multilevel interconnects"

45 nm-node multilevel Cu interconnects with porous-ultra-low-k have successfully been integrated. Key features to realize 45 nm-node interconnects are as follows: 1) porous ultra-low-k material NCS (nano-clustering silica) has been applied to both wire-level and via-level dielectrics (what we call full-NCS structure), and its sufficient

robustness has been demonstrated; 2) 70-nm vias have been formed by high-NA 193 nm lithography with fine-tuned model-based OPC and multi-hard-mask dual-damascene process-more than 90% yields of 1 M via chains have been obtained; 3) good TDDB (time-dependent dielectric breakdown) characteristics of 70 nm wire spacing filled with NCS has been achieved. Because it is considered that the applied-voltage (Vdd) of a 45 nm-node technology will be almost the same as that of the previous technology, the dielectrics have to endure the high electrical field. NCS in Cu wiring has excellent insulating properties without any pore sealing materials which cause either the keffvalue or actual wire width to be worse. [C2454]

"Wigner simulation of the transition of a 'single' to 'double' barrier DMS device"

The presence of dilute magnetic semiconductors (DMS) enriches the design potential of nano scale barrier devices. Placement of these DMS layers within or adjacent to a barrier can effectively lower or raise the barrier height for carriers of different spin and thereby introduce separate but coupled components of current. The magnetic field in high g-factor devices then can function as a pseudo third terminal. In anticipation of an n-type technology with these materials we examine the development of a barrier device that contains a DMS layer strategically placed so that in the presence of a magnetic field the barrier device is transformed into a double barrier device. The goal of this design is to create a device that will show tunneling resonances. Some early calculations with this structure will be presented showing the possibilities, pitfalls and potential for designing such a structure. [C2455]

"Self-assembled nanowire-on-insulator (SANOI) for nano-chip technology"

One-dimensional semiconducting nanowires (Si or Ge) directly synthesized on insulator layer by chemical method provide a viable technology analogous to silicon-on-insulator (SOI) and germanium-on-insulator (GOI), yet presenting much better chip design/integration flexibility, structural scalability, and cost-effectiveness. The new technology, called self-assembled nanowire-on-insulator (SANOI), illustrates a good example of how bottom-up nanotechnology based on inexpensive chemistry may provide solution to some of the most daunting challenges in the conventional silicon CMOS scaling. [C2456]

"Minimal area homogeneous logic circuits using nano-wires"

This paper presents an homogeneous (array-based) approach for designing and manufacturing digital circuits using nanotubes/nano-wires. As "a strategy for developing integrated devices with many individual elements has yet to be formulated", it is evident that such an environment is a necessity for designing circuits using nano-wires. At logic level, a novel formulation for area reduction is proposed and solved in polynomial time using a heuristic technique. It is analyzed that 40% saving in the area of physical mask layout is possible due to the small diameter of nano-wires and the proposed area optimization approach. [C2457]

"Nano liquid handling with bio-actuated micro heart pump powered by cardiomyocytes sheet"

We have succeeded in the creation of a new fluid handling system in a microspace using cultured cardiomyocytes as a component of a micropump. In order to communicate the force generated by cardiomyocytes to fluid, a thin diaphragm and a push bar structure made of PDMS were assembled onto a microchannel and cardiomyocytes sheet was attached on them. Estimated flow rate of this micropump was 52 nL/min. The applied pressure on the diaphragm generated by cardiomyocytes was 2Pa. This is the first demonstration of microheart pump using cardiomyocytes sheet only by chemical energy without electrical power supply. [C2458]

"Effect of CMP downward pressure on nano-scale residual stresses in dielectric films with Cu interconnects assessed by cathodoluminescence spectroscopy"

Engineering of the residual stress fields related to the backend process of LSI devices with Cu interconnects is required together with the adoption of low-k materials that have quite low Young's modulus. We measured the nano-scale residual stresses stored within interlayer dielectric (ILD) films according to a cathodoluminescence piezospectroscopic technique. We confirmed that stresses in ILD could be successfully detected with less than 50 nm resolution and that a higher chemical mechanical polishing (CMP) downward pressure led to a shift toward the tensile side of the residual stress field stored in the ILD film. [C2459]

"Low temperature interconnect technology using surface activated bonding (SAB) method"

SAB is a process for bonding surfaces which have been cleaned and activated by ion beam bombardment or plasma irradiation. The concept is based on the reactivity of atomically clean surfaces of solids and the formation of chemical bonds on contact between such clean and activated surfaces. The bonding procedure consists of

cleaning followed by contact in ultra-high vacuum or in a certain ambient atmosphere. The highly activated surfaces enable them to bond to each other at a lower temperature than the conventional bonding process. This paper reviews the development and current status of the SAB process. A high-density bumpless interconnect for Cu electrodes (3 μm in diameter, 10 μm pitch) of 100,000 pieces at room temperature, and its application on the assembly of a flash memory card are demonstrated. Two new additional processes using a nano-layer adhesion and a sequential activation process are proposed for bonding of ionic materials such as SiO_2 , glass and LiNbO_3 . [C2460]

"Challenges and opportunities in nano-scale VLSI design"

Moore's law continues to drive the scaling of CMOS technology (Moore, 1965), The feature size of the transistor now has been shrunk well into nano-scale region (Bohr, 2002). A large single VLSI chip can contain over one billion transistors. The ever-increasing level of integration has enabled higher performance and richer feature sets on a single chip. This has led to the explosive growth of microelectronics industry over last decades. But as the geometry of the transistor is getting smaller and the number of transistors on a single chip grows exponentially, the power management for a state-of-the-art VLSI design has become increasingly important. To maintain the performance trend of the VLSI system as the technology scaling continues, many advanced design techniques, especially in power management, have to be employed in order to achieve a balanced design to meet platform and end-user needs. [C2461]

"Interconnects for nanoelectronics"

In the nanoelectronics era with ever smaller devices and higher densities, there are challenges of signal transmission and information communications via interconnects. We examine the interconnect issues for both charge-based and spin-based information systems. For charge-based systems, since there are substantial activities in optical interconnect, this paper focuses on other concepts and approaches. Self-assembled molecular wires, carbon nanotubes/nanowires and virus engineered metallic wires can be used for interconnects. The use of new nano-architectures such as cellular automata, which use mostly nearest neighbors, make the use of self-assembled interconnects even more attractive. These techniques may be applied readily to molecular devices. Spin-based devices offer a new opportunity for low power, high functional throughput applications. We analyze the use of spin waves for information transmission buses referred to as spin wave bus. By introducing these novel circuits built on the spin-based devices and spin wave interconnect, we anticipate enhanced logic functionality. The challenges and issues are discussed. [C2462]

"Emerging devices for post-classical CMOS-from memory, logic to architectures"

The pace of MOSFET scaling has been obviously accelerated recently, and the simple scaling of MOSFET will not work for higher integration and higher performance in future. The introduction of nonclassical CMOS design using new transistor structures and new materials is urgent. Moreover, new research work has started on the invention of fundamentally new information processing and storage for future integrated systems. In this paper, the present status of the research on emerging nonclassical CMOS, emerging memories, and emerging new architecture devices is reviewed. Special emphasis is placed on the nano-scale devices that positively utilize new physical phenomena in nanostructures. [C2463]

"Ambient intelligence: gigascale dreams and nanoscale realities"

Ambient intelligence (Aml) is a vision of a world in which people will be surrounded by networks of intelligent devices that are sensitive and adaptive to their needs. This concept implies a consumer-oriented industry driven by software from the top, and enabled (and constrained) by nano-scale physics at the atomic level. "More-Moore" will be needed to deliver the giga-ops computation and GHz communication capabilities required for stationary and wearable devices. But Aml also creates new challenges at the architectural and physical levels. To make Aml possible, Aml devices need two-orders-of-magnitude-lower power dissipation than today's microprocessors, at one-twentieth of the cost. These requirements conflict with the embedded programmability needed for personalization and adaptation to new services. We focus on emerging techniques for bridging this gap between software-centric systems and power-efficient platform architectures for Aml devices. A second challenge is to cope with the fact that nano-scale physical phenomena are in conflict with the traditional "nice and predictable" digital abstractions now used for complexity management. Techniques for coping with uncertainty and signal degradation, while achieving better-than-worst-case design, are discussed. Finally, one must realize that, to facilitate Aml, "more-than-Moore" technology is required, for example, for the design of autonomous wireless sensor networks. Correspondingly, attention is paid to novel combinations of technologies above and around CMOS, for the design of ultra-low-power, ultra-simple sensor motes for Aml. [C2464]

"Nanoelectronics for an ubiquitous information society"

Nanoelectronics will open up both new opportunities and new challenges. Already, it has been successfully used in mass production of gigabit memories, including flash and DRAM, and in field-emission displays (FED) with carbon nanotubes. The technical challenge is to deal with process and device parameter variation, while the economic challenge is to reduce the high cost of fabrication. One way to overcome these technical and economic uncertainties is to organize a tight collaboration of the device industry with system and service industries, to distribute the risk, and to maximize the total social benefit. The "IT 839 Strategy" of the Korean government is an example of such a program to enhance cooperation amongst service, system, and device industries, to speed up the use of nanoelectronics for the realization of a ubiquitous information society. In such a society, information technology (IT) enables everyone to enjoy daily life without being aware of IT itself. This is made possible by the "invisible silicon" that resides within almost everything in our society, to sense, analyze, and control us and our environment. Nanoelectronics allows the mass production of such new silicon. RFID chips and sensor networks are examples of "invisible silicon", which can integrate nano-electromechanical systems and RF technology, as well as low-power and multimedia SoCs. These technologies will facilitate future IT, and change our world, just as fourth-generation mobile-phone developments are leading us to the ubiquitous information society. [C2465]

"Nano-wires for room temperature operated hybrid CMOS-NANO integrated circuits"

N-doped polysilicon gated-nanowires (poly-SiNW) are reported. The V-shape and hysteresis of their I-V characteristics are used to build analog and memory circuit cells. Integration of the poly-SiNW in CMOS is demonstrated. A precise current-measurement application with 1pA resolution and negative differential resistor is reported. A nanoscale capacitor-less hysteresis memory cell using constant-current biased poly-SiNW is designed and experimentally validated. [C2466]

"A 146 mm² 8 Gb NAND flash memory with 70 nm CMOS technology"

A 146 mm² 8 Gb NANO flash memory with 4-level programmed cells is fabricated in a 70 nm CMOS technology. A single-sided pad architecture and extended block-addressing scheme without redundancy is adopted for die size reduction. The programming throughput is 6 MB/s and is comparable to binary flash memories. [C2467]

"Maximum likelihood subspace identification for linear, nonlinear, and closed-loop systems"

This tutorial paper presents a first principles development of subspace system identification (ID) using a fundamental statistical approach. This includes basic concepts of reduced rank modeling of ill-conditioned data to obtain the most appropriate statistical model structure and order using optimal maximum likelihood methods. These principles are first applied to the well developed subspace ID of linear dynamic models; and using recent results, it is extended to closed-loop linear systems and then general nonlinear closed-loop systems. The fundamental statistical approach gives expressions of the multistep likelihood function for subspace identification of both linear and nonlinear systems. This leads to direct estimation of the parameters using singular value decomposition type methods that avoid iterative nonlinear parameter optimization. The result is statistically optimal maximum likelihood parameter estimates and likelihood ratio tests of hypotheses. The parameter estimates have optimal Cramer-Rao lower bound accuracy, and the likelihood ratio hypothesis tests on model structure, model change, and process faults produce optimal decisions. The extension to general nonlinear systems determines optimal nonlinear functions of the past and future using the theory of maximal correlation. This gives the nonlinear canonical variate analysis. New results show that to avoid redundancy and obtain Gaussian variables, it is necessary to determine independent canonical variables that are then used in the likelihood function evaluation. These new results greatly extend the possible applications of subspace ID to closed-loop linear and nonlinear systems for monitoring, fault detection, control design, and robust and adaptive control. Potential applications include system fault detection for control reconfiguration, autonomous system monitoring and learning control, and highly nonlinear processes in emerging fields such as bioinformatics and nano technology. Applications are discussed to identification of vibrating structures under feedback including online adaptive control of aircraft wing flutter, and identification of the chaotic Lorenz attractor. [C2468]

"An autonomous SRAM with on-chip sensors in an 80nm double stacked cell technology"

An active solution to overcome the uncertainty and fluctuation in nano technology SRAM is introduced. It automatically adapts SRAM's operation optimized for the process variation and operating environments by using on-chip timer, temperature sensor, substrate noise manager and leakage current monitor. A test SRAM chip fabricated with an 80nm SRAM process, shows that average power consumption is reduced by 9%, and the standard deviation decreases by 58%. [C2469]

"Processing of Alumina Nano-films"

{no data available} [C2470]

"Controlled deposition of electrospun poly(ethylene oxide) fibers via insulators"

Electrospinning is a subjecting of a fluid jet to a high electric field process, by which polymer fibers with nano-scale diameters lower than 100 nm are formed. Significant progress has been made in this area throughout the past few years and this technology has been exploited to a wide range of applications. However, the efficiency is still very low because the repelling force could not be controlled between two needles. For the investigation, two needles were used. And 3 kinds of insulators, including polytetrafluoroethylene (PTFE) tube, polyvinyl chloride resin (PVC) tube and silicon rubber tube, were invited to overcome the repelling force. It is concluded that it is possible to provide a more controllable and easily achieved electrospinning process by using insulators. [C2471]

"Memory technologies in the nano-era: challenges and opportunities"

As we move into the nano-era, there are growing concerns about the future of conventional memories due to their increasing technical complexity, fabrication cost, and scalability issues. In this paper, technical challenges and recent breakthroughs in conventional memories, and the future directions of memory development including new types of memories are introduced and discussed. [C2472]

"Development of a MOEMS sun sensor for space applications"

The paper presents the development of a miniaturized sun sensor for sun angle detection in space applications. The sun sensor has a field of view (FoV) of greater than 2π sr and a resolution of approximately 1 degree in elevation and azimuth angle; thus, it is a coarse sun sensor with the advantage of having a large field of view. Key elements of this sun sensor are its curved shape, the photosensitive layer consisting of copper indium gallium diselenide (CIGS), the transparent conductive layer consisting of thin molybdenum or aluminium doped zinc oxide, and its integrated design. The sun sensor will be one of the sensors in the attitude determination and control system (ADCS) of a nano-satellite. [C2473]

"Technology and integration of poly-crystalline diamond piezoresistive position sensor for cochlear implant probe"

The possible use of polycrystalline diamond (poly-C) as a piezoresistive position sensor in a cochlear prosthesis is being investigated for the first time. The fabrication process of the poly-C thin film was optimized for compatibility and integration with the Si-based bulk micromachining technology of the cochlear probe. In-situ doped poly-C, films, with a thickness of 1 μm , were grown on insulating substrates using MPCVD and patterned by ECR-assisted plasma etching. The piezoresistors can be used as position sensors to detect the curvature and position of the probe during implant surgery. The film quality, electrical properties, contact resistance and piezoresistivity of the poly-C sensors were characterized, which demonstrated a successful integration of diamond technology with the microsystem technology. A gauge factor of 28 was achieved for the poly-C sensors on the probe. [C2474]

"Temperature-dependent fracture toughness of single-crystal-silicon film"

We evaluated the fracture toughness of micron-sized single-crystal-silicon film at temperatures ranging from 293 K to 773 K by using an "on-chip" tensile testing method. We made a 1- μm -long notch on one side of a thin film specimen using a focused ion beam (FIB) process. The fracture toughness was 1.29 MPa $\sqrt{\text{m}}$ at room temperature. It rapidly increased at 353 K, reaching almost double that at room temperature and then saturated at higher temperatures. A few specimens tested at 423 K and 573 K showed a non-linear relationship between stress and strain due to plastic deformation around the notch. [C2475]

"The AFM tweezers: integration of a tweezers function with an AFM probe"

A prototype of AFM (atomic force microscope) tweezers is presented. In order to combine the function of nano objects manipulation with AFM observation, we have developed a tweezers-type AFM probe device using micromachining technology. The device has two thin wedge-type arms shaped by anisotropic etching and local oxidation of silicon techniques; one arm plays the role of an AFM probe, and another plays that of a manipulation probe in cooperation with monolithically fabricated microactuators. We have successfully demonstrated the function of picking up nanoparticles by the developed AFM tweezers. [C2476]

"Synthesis and electric properties of nano-hybrid polyimide/silica film"

In this paper, a kind of nano-hybrid polyimide/silica film was prepared in-situ using Methyltriethoxysilane as the

precursor of the inorganic moiety through sol-gel reaction in the polyamic acid of N, N-dimethylacetamide solution. The surface morphology of the film was characterized by atomic force microscope (AFM) and compared with each other as aminopropyltriethoxysilane that served as a kind of coupling agent was, in addition, introduced into one of the hybrid systems. And the electric properties such as dielectric constant ϵ , dielectric loss $\tan \delta$, and volume resistance ρ_v with SiO_2 content and the morphology between the organic and inorganic phases were discussed. It turned out by the experiments that the incorporation of the inorganic moiety, its content variation and the character of interface between the two phases had great effects on the properties of the hybrid film compared with the pure polyimide film. [C2477]

"Synthesis and characterization of silica-alumina co-doped polyimide film"

A new class of polyimide/silica-alumina (PI/ SiO_2 - Al_2O_3) composite film was prepared by synthesizing ceramic oligomers through sol-gel reaction using tetraethoxysilane (TEOS) and heteropropyl-aluminium (HPAl) as the inorganic precursors and incorporating them into polyamic acid (PAA) derived from pyromellitic dianhydride (PMDA) and 4,4'-oxydianiline (ODA) in N,N-diethylacetamide (DMAc). The chemical structure of the hybrid polyimide film was characterized by FTIR. And the surface morphology of the film was characterized by AFM. It turned out that a kind of co-doped polyimide film containing a homogeneous dispersion of SiO_2 and Al_2O_3 particles was obtained. And when the content of the inorganic moieties was not beyond 10% SiO_2 and 5% Al_2O_3 (wt%), the size of the ceramic particle was in the range of nano-level, besides, the film was golden and transparent. [C2478]

"A novel fabrication of ionic polymer-metal composites (IPMC) actuator with silver nano-powders"

This article reports a novel approach of applying silver nanopowders to the fabrication of an ionic polymer-metal composites (IPMC) actuator with good adhesion between the electrodes and membrane without surface roughening pretreatment at low cost, high repeatability and short process time. Microfabrication technologies are used for this IPMC actuator fabrication including the dissolving and casting of silver nanoparticles (35 nm) in Nafion diluted solution followed embossing, nontoxic electroless plating of silver, and microelectroforming of nickel. This IPMC actuator exhibits large deformation of bending curvature angle more than 90° at lower driving voltage of 3 V. The electronic active polymer, IPMC, could be potentially used as the actuator of the active guide-wire, effective biomimetic sensor and artificial muscles. [C2479]

"Novel process flow for the integration of carbon nanotubes into MEMS"

We present a process flow and characterization for the growth of freestanding carbon nanotubes on a polysilicon microelectromechanical device. Individual or multiple tubes can be directly grown between movable posts and electrically connected. The process is characterized to the point where minimum feature sizes of catalytic islands are determined as a function of the catalytic solution concentration. We show scanning electron microscopy pictures that validate the direct growth of nanotubes. The reported technology is batch-fabrication compatible as opposed to discrete fabrication processes and is opening the way to the synthesis and evaluation of mechanical nano-scale transducers based on carbon nanotubes. [C2480]

"Reliable and self-repairing SRAM in nano-scale technologies using leakage and delay monitoring"

The inter-die and intra-die variations in process parameters result in large number of failures in an SRAM array degrading the design yield. In this paper, we propose an adaptive repairing technique for SRAM based on leakage and delay monitoring. Leakage and delay monitoring is used to effectively separate dies with different inter-die V_t s from each other. Using the leakage (or delay) monitoring and adaptive body bias, we propose a reliable and self-repairing SRAM which has reduced number of parametric failures under high inter-die and intra-die V_t variations. The proposed self-repairing SRAM improves the design yield by 5%-40% in predictive 70nm technology from BPTM [C2481]

"Micro and Nano Scale Electric Machines and Applications of Power Electronics"

This paper addresses fundamental issues that would bring into effect the power electronic control of micro and nano scale electric machines. The paper takes the step-by-step approach of developing a control strategy that is described in two stages namely the machine stage and the power electronic drive stage. A brief overview of two popular types of micro and nano electric machines namely the electrostatic and electromagnetic and the scaling of various machine related physical magnitudes are presented in the machine analysis stage. The drive stage analysis is carried out by presenting the non-steady state dynamic performance of the machine and the application of control strategies to realize a complete micro/nano control system. The area of nano power electronics and motor drives have recently been the most intensive area of concentration for researchers of all fields including electronics and electrical engineering, biotechnology, physics, and chemistry. Nano scale

machinery drives are now bringing new phase of power generation and distribution concepts. These would define the latest advancements in the solid-state device technology to make nanometer dimensional nano power switches and devices to be operated for molecular scale circuits and devices. Micro and nano scale electromechanical systems, which function with many nano scale elements, are very useful for different purposes in medical science and many other areas [C2482]

"Innovative actuators and tools for micro-nano mechatronics"

Applications of actuators have increased in various fields. In industry, precise and high speed positioning is one of the most important technologies. In peripheral machines for computers like disc memories, small and thin actuators are necessary to satisfy the demand of reduction of thickness and weight of the products. In some cases conventional actuators seem to be difficult to satisfy these new and advanced demands. Therefore, seeking for new actuators has been activated recently. Especially, in the field of MEMS, where the dominant physical rules are different from those of the usual size, new small actuators utilizing electrostatic force, heat deformation, piezoelectric materials, shape memory, and so on have been proposed and developed. Among the new actuators, impact drive mechanism and surface acoustic wave motor are introduced as examples of piezoactuators. And as examples of actuators and manipulations using electrostatic force, powerful electrostatic motor, thin film electrostatic motor, electrostatic transportation devices of particles and droplets, and electrostatic suspension are described. [C2483]

"Continuum computer architecture for nano-scale and ultra-high clock rate technologies"

Continuum computer architecture (CCA) is a non-von Neumann architecture that offers an alternative to conventional structures as digital technology evolves towards nano-scale and the ultimate flat-lining of Moore's law. Coincidentally, it also defines a model of architecture particularly well suited to logic classes that exhibit ultra-high clock rates (>100 GHz) such as rapid single flux quantum (RSFQ) gates. CCA eliminates the concept of the "CPU" that has dominated computer architecture since its inception more than half a century ago and establishes a new local element that merges the properties of state storage, state transfer, and state operation. A CCA system architecture is a simple multidimensional organization of these elemental blocks and physically may be considered as a new family of cellular computer. But CCA differs dramatically from conventional cellular automata. While both deliver emergent global behavior from the aggregation of local rules and ensuing operation. The CCA emergent behavior is a global general-purpose model of parallel computation, as opposed to simply mimicking some limited phenomenon like heat and mass transfer as do conventional cellular automata. This paper presents the motivation and foundation concepts of CCA and exposes key issues for further work. [C2484]

"New Developments in Gallium Nitride and the Impact on Power Electronics"

Wide bandgap III-nitride semiconductor materials possess superior material properties as compared to silicon, GaAs and other III-V compound materials. Recent achievements in gallium nitride (GaN) technology for optoelectronics have resulted in ultra-bright blue light emitting diodes and lasers, ultraviolet emitters, and solar-blind optical detectors. In the electronic area, drastic improvement of microwave device performance has been achieved, yielding record high power densities of 20-30 W/mm. Novel applications of these materials in high-power electronics for switching, energy conversion and control are just emerging. This paper provides an overview of the state-of-the-art III-nitride wide bandgap technologies and it explores power electronic applications while illustrating the enormous potential that GaN based devices have for overcoming the major challenges of power electronics in the 21st century. The paper discusses the unique material and device properties of GaN-based semiconductors that make them promising for high-power, high-temperature applications. These include high electron mobility and saturation velocity, high sheet carrier concentration at heterojunction interfaces, high breakdown voltages, and low thermal impedance (when grown over SiC or bulk AlN substrates). The chemical inertness and radiation hardness of nitrides are other key properties. As applied to power electronics, the III-Nitride technology allows for high-power switching with sub-microsecond and nano-second switching times. The paper will present the innovations that further improve the performance of high-power DC-DC converters, switches and other building blocks. These include novel insulated gate HFET design that significantly expands the allowable input voltage amplitude, further increases the device peak currents, and most importantly, tremendously improves the large-signal stability and reliability. Insulated gate switching devices have been shown to operate at up to 300 degC with no noticeable parameter degradation. Novel monolithic integrated circuits of high-power switches and DC-DC converters and their performance parameters will be presented. The paper also discusses the major challenges associated with modern GaN technology and work in progress to overcome them [C2485]

"Near-infrared femtosecond laser-processed thin-film transistor"

Near-infrared (800 nm wavelength) femtosecond laser annealing (FLA) is employed on crystallization and activation of amorphous Si regions of thin film transistors (TFT). The transfer, and output characteristics for FLA-processed TFTs show promising performances. [C2486]

"The Joint 30th International Conference on Infrared and Millimeter Waves (IEEE Cat. No. 05EX1150)"

{no data available} [C2487]

"Leakage Current Based Stabilization Scheme for Robust Sense-Amplifier Design for Yield Enhancement in Nano-scale SRAM"

In this paper, we develop a method to analyze the probability of access failure in SRAM array (due to random V_t variation in transistors) by jointly considering variations in cell and sense amplifiers. Our analysis shows that, improving robustness of sense amplifier is extremely important for reducing memory access failure probability and improving yield. We present a process variation tolerant sense amplifier suitable for SRAM array designed in sub-100nm CMOS technologies. The proposed technique reduces the failure probability of sense amplifiers by more than 80% with negligible penalty in the sensing delay. [C2488]

"An analysis: traditional semiconductor lithography versus emerging technology (nano imprint)"

The introduction of emerging technologies into existing manufacturing facilities is not necessarily encouraged by the people responsible for the output of the facilities. Any "new" technology carries risks and people responsible for delivering manufactured products are, by nature, risk-adverse. This paper demonstrates the advantage of evaluating the impact of attempting to introduce a new technology into an existing facility before actually attempting the introduction. The first part of the analysis examines the impact on the total product delivery for a comparable volume of two facilities, one with the traditional processes and one with the new process replacing existing ones. Based on these results, a conclusion can be reached if there are sufficient benefits to consider pursuing the development and introduction of the new techniques. An example is employed that evaluates the introduction of nano-imprint. [C2489]

"Fabrication and characterization of AFM probe with crystal-quartz tuning fork structure"

We have developed a new type of crystal quartz probe structure for application to the atomic force microscopy (AFM) system. Using quartz micromachining technology and a focused-ion-beam system, we fabricated a device in which we integrate tuning fork structure and a probe tip. We evaluated the vibration characteristic of the fabricated tuning fork by measuring its frequency response. From these results, we found that it would achieve subnanometer scale resolution in an AFM system. [C2490]

"Nano-mechanical analysis through manipulating protein molecules with AFM"

The authors are developing nanomechanical method to study protein structure in order to establish a method to understand mechanical and physical side of protein function. Using atomic force microscope (AFM), mechanically forced extensions of molecule were examined, where fine differences in conformation were detectable. Adhesive forces between molecules have also been studied worldwide and the future of mechanical approach to study biomolecules seems to be promising. A study on nano-mechanics of chaperonine molecule that helps denatured protein to fold correctly using compression-free force spectroscopy is shown. [C2491]

"Nanofabrication of inorganic structures utilizing biotechnology"

Several research groups proposed the introduction of biomolecules into the semiconductor process (Yamashita, 2001; Hikono et al., 2003). We proposed the fabrication of key component of quantum electronic devices and named the process bio nano process (BNP). The first step is making inorganic or semiconductor nanoparticle (NP) or nanowire (NW) in the protein cavity by biomineralization. The second step is aligning these hetero-complex, inner NP/NW and outer protein, on the substrate by self-organization via interaction of the protein surface. The last step is eliminating protein moiety and making inorganic nanostructures for devices. The essences of the BNP is the combination of protein homogeneity, biomineralization, and self-assembly. NPs or NWs biomineralized in the protein cavities are the same size and the protein shell surrounding them serve to make nanostructures by self-assembly. [C2492]

"On proximity effect in electron beam induced deposition"

Beam induced deposition is versatile technique to fabricate nano-structure. In this paper, the proximity effect in

electron beam induced deposition was studied, and the beam scan sequence which minimizes the effect was suggested. [C2493]

"Soft X-ray emission and absorption spectra of DLC film formed by FIB-CVD method"

It is known that focused ion beam chemical vapor deposition (FIB-CVD) is useful to form 3D nano-structures. In this method, carbon based material was formed by gallium focused ion beam assisted deposition using phenanthrene as a carbon source. In the previous study, carbon thin film formed by FIB-CVD was considered to be diamond like carbon (DLC), however, the structural properties based on electronic states have not been sufficiently understood. In the present study, we investigate the electronic states of carbon thin film formed by FIB-CVD method by the measurement of near edge X-ray absorption fine structure (NEXAS) of the carbon K edge using synchrotron radiation. In addition, soft X-ray emission spectrum was observed with an electron probe microanalyzer (EPMA). [C2494]

"Scalable probabilistic computing models using Bayesian networks"

As technology scales below 100nm and operating frequencies increase, correct operation of nano-CMOS will be compromised due reduced device-to-device distance, imperfections, and low noise and voltage margins. Unlike traditional faults and defects, these errors are expected to be transient in nature. Unlike radiation related upset errors, the propensity of these transient errors will be higher. Due to these highly likely errors, it is more appropriate to model nano-domain computing as probabilistic rather than deterministic events. We propose the formalism of probabilistic Bayesian networks (BNs), which also forms a complete joint probability model, for probabilistic computing. Using the exact probabilistic inference scheme known as clustering, we show that for a circuit with about 250 gates the output error estimation time is less than three seconds on a 2GHz processor. This is three orders of magnitude faster than a recently proposed method for probabilistic computing using transfer matrices [C2495]

"Temperature effects on fracture behavior of notched silicon film specimen"

We performed tensile tests on single-crystal-silicon film at temperatures ranging from RT (room temperature) to 600°C. We made notched specimens by using a focused ion beam (FIB) process. The fracture toughness did not change from room temperature to 60°C. However, between 60°C and 80°C, it rapidly increased to almost double that at room temperature, and it saturated at temperatures higher than 80°C. Some specimens tested at 150°C and 300°C showed the nonlinear relationships between stress and strain. Shapes of the fractures that occurred from 80°C to 600°C were clearly different from the fracture shape at 60°C. These results suggest that dislocation motion occurred even at low temperatures near 80°C. [C2496]

"Fast-scanning AFM is now applicable to the analyses of single-molecule reactions in nano-biophysics"

Atomic force microscopy (AFM) has been used to visualize nano-scale structures of DNA, proteins and higher-order structures of DNA/protein complexes, such as chromatin and chromosome. Recently, there has been remarkable progress to visualize reaction dynamics at a single molecular level in real time and to measure a single molecular kinetics by using newly developed fast-scanning AFM. In this paper, we addressed these recent applications of fast-scanning AFM technology. With this novel technology, we succeeded to visualize the DNA cleavage reaction by a type IIP restriction endonuclease Apal and to kinetically analyze the chaperonin (GroEL) cochaperonin (GroES) at a single molecular level. Thus, the fast-scanning AFM is powerful to understand protein structures and dynamics in biological reactions at the single molecule level in sub-seconds [C2497]

"A block-level optimization of comprehensive thermal-aware power management for SoC integration in nano-scale CMOS technology"

Modern SoC integrations and mobile systems have emphasized low power techniques due to shortage of battery life. Conventional power management designs focused on the reduction of dynamic power consumption, recent designs begin to take leakage power into consideration since it becomes an important factor in nano-scale CMOS technology. Latest development has taken advantage of modularity in SoC design methodology to develop the block-level control technique for power reductions. However, thermal gradient over the system and its impacts to SoC designs are barely discussed. In this research, a block-level optimization of comprehensive thermal-aware power management is presented. The proposed design applies several low power techniques to control different power sources and handles thermal impacts to provide performance coherence. As a result, optimal power-reductions and performance coherence can be guaranteed within the whole system. The simulation results show a significant improvement in stability and leakage power reduction for most circuitries.

The results are based on TSMC 100 nm CMOS technology. [C2498]

"Extremely High Current, High-Brightness Energy Recovery Linac"

Next generation light-sources, electron coolers, high-power FELs, Compton X-ray sources and many other accelerators were made possible by the emerging technology of high-power, high-brightness electron beams. In order to get the anticipated performance level of ampere-class currents, many technological barriers are yet to be broken. BNL's Collider-Accelerator Department is pursuing some of these technologies for its electron cooling of RHIC application, as well as a possible future electron-hadron collider. We will describe work on CW, high-current and high-brightness electron beams. This will include a description of a superconducting, laser-photocathode RF gun and an accelerator cavity capable of producing low emittance (about 1 micron rms normalized) one nano-Coulomb bunches at currents of the order of one ampere average. [C2499]

"Nano photonic sensors for microdamage detection: an exploratory simulation"

Nano photonic materials are synthetically manufactured crystals at the nano scale with the target of creating a microstructure with a special electro-magnetic periodicity. Such nano photonic materials have the ability to control light propagation and thus are capable of creating photonic bandgaps in the frequency domain. We propose using nano photonic crystals as sensors to detect microdamage in composite materials. We demonstrate using a simulation model that a nano photonic sensor attached to a composite bar experiences a significant change in its bandgap profile when damage is induced in the composite bar. The model predicts the frequency response of the nano photonic sensor using the transfer matrix method. A damage metric to evaluate the change in the frequency response is developed. Successful developments of nano photonic sensors allow damage identification at scales not attainable using current sensing technologies. [C2500]

"About some methods of nano structures forming in ELIC-technology"

The studies were conducted with various methods of structures forming including nanometer-sized elements resulting in the choosing of the most efficient technological direction, which allows to create a radically new ELIC element base [C2501]

"Models of nanoelectronic devices on single-electron, resonant tunneling effects and quantum wires for nano and microsystem equipment"

The models of nanoelectronic devices on single-electron tunneling, resonant tunneling effects and quantum wires are described. These models have been included into a new version of nanoelectronic device simulator NANODEV for PC. New models allow to simulate other devices including more complex structures. Principles of simulator design have been left without change. At present, we use several formalisms such formalism of wave functions, formalism of scattering matrix and formalism of Wigner function. For each class of nanoelectronic devices, different hierarchy models can be used. The principles allow to realize modification of the system in order to increase its possibilities [C2502]

"A VCO with high supply noise rejection and its application to PLL frequency synthesizer"

A CMOS voltage-controlled oscillator (VCO) with high supply noise rejection is designed, and its application to a phase-locked loop (PLL) frequency synthesizer is also presented. In the VCO design, voltage regulator is used to suppress high and low frequency noise by isolation from power supply and to make stable internal voltage for oscillator; dual-path oscillator is adopted and a modification is made in voltage-current converter to extend the VCO voltage-frequency convert linearity range. Other circuits in the PLL are also designed from the low noise perspective. Simulation results under 0.2 μm TSMC CMOS process show that the VCO output frequency ranged from 0.234 GHz to 2.57 GHz, with control voltage turning range of 81% and linearity of 5.8%, 1 V supply voltage change induces 1.5 ps VCO period change when its output frequency is at 1.8 GHz; the PLL has a frequency range of 0.338 GHz to 2.26 GHz, and with 22 ps peak-to-peak jitter at 1.8 GHz. [C2503]

"A novel timing jitter resist method in UWB systems"

Ultra wideband (UWB) is a kind of wireless communication system which can perform high data rate with nano-second pulses of baseband, and has recently received much attention for short-range applications. Thus a high sensitivity of timing synchronization between modulation and demodulation is required. Timing synchronization error named timing jitter between transmitter and receiver has been introduced and their properties have been analyzed in some papers. However, there are not many methods brought forward to improve the system performance in the scenarios that deteriorated jitter existents. We consider this problem and offer a method to resist the adverse effect by timing jitter to the whole system by adopting a new designed correlator reference

signal in UWB receiver. This reference signal is formed corresponding to the timing jitter distribution of the received pulses waveforms to increase the jitter robust performance. From the simulation results of different UWB modulation systems, better performance can be achieved by adopting this reference signal in the receiver than the conventional schemes. [C2504]

"Regular nanocones on carbon-silicon composite surface"

Presented in this paper is a new effect of nanostructuring, namely the formation of nano-cones under the action of local electric field induced in carbon-silicon composite films underneath the SPM probe [C2505]

"Energy conversion of nano-cantilever beam with forced vibration in low vacuum housing"

The study of damping as the micro-resonator is vibrating has been a most important aspect which effects and pushes the development of resonator. The most effective measure to achieve high working capability is to encapsulate the resonator structure in housing where air is rarefied. However, in most cases, it is very difficult to realize the absolute vacuum in the housing. Therefore, it is important to study the effect of damping for resonator. In this paper, nano-cantilever beam which is widely used in resonator is analyzed, and molecular dynamics simulation method is used to study energy conversion problem when the beam is encapsulated in different vacuum degree housing. The width and high of the nano-cantilever beam is equal and is 2.172nm, and the length is 10.860nm. By adopting Tersoff function, potential energy between beam atoms is calculated. After relaxation, it is found that the length of beam is shorten about three percent, and the area of cross section is increased slightly, furthermore the area of cross section on two end sides is lightly more than the area of the middle cross section of the beam. On the other hand, the distortion of the beam with forced vibration is simulated on the condition that the pressure in the housing is from 1000pa to 1pa. From experimental data we can found that the losing energy for collision between air molecules and beam atoms is gradually decreased with the pressure reduced. In the same condition, the losing energy is almost linear increasing with the time increased. The line slope was decreased from 0.03934362 at 1000pa pressure to 0.00003964 at 1pa pressure. When the pressure in the housing is reduced to zero, namely absolute vacuum, the energy got by the beam from outside force is changed periodically with the time change. For the energy from beam gravity is at 10-12ev degree, the gravity effect for whole beam system is so small that it can be neglected as well as the macro-structure. The above-mentioned results are useful to design and optimize the parameters of nano-structure, and provide the academic foundation for MEMS/NEMS developing [C2506]

"Synthesis of undercoat with high temperature and humidity resistance for resistor"

Epoxy resin undercoat, with high temperature and humidity resistance, for resistor was prepared by curing of acid anhydride and accelerating of glycol with proper nano-SiO₂ added at 80°C. The properties of undercoat prepared were characterized by electrical tests, infrared spectra (IR), thermogravimetric analysis (TGA) and scanning electron microscopy (SEM). The results showed more compact and steady inter-crosslinked network structure was formed in the modified epoxy resins undercoat with nano-SiO₂ added, which led to the performance of modified epoxy resin undercoat improved greatly. The undercoat with nano-SiO₂ 2.68wt%, kept for six months at room temperature without flocculating and aggregating, is of good stability. The varying ratio of resistance with such undercoat painted is less than 1% after high temperature and humidity resistance test. In this work, an attempt has been made to prepare undercoat, with high temperature and humidity resistance, for resistor by modifying epoxy resin using nano-SiO₂. [C2507]

"Characterization of the bending creep behavior for electroplating nickel microbeam"

This study aims to investigate the creep behavior of electroplating nickel film using bending micromachined cantilever approach. The bending test including quasi-static, reloading, and time-dependent creep were performed by using a nano-indentation loading system. The resulting Young's modulus and yielding strength were determined through mechanical testing, and the experimental average values are 191 GPa and 0.79 GPa, respectively. In addition, by measuring the load-deflection of micro cantilever under various stress levels with a constant temperature, the bending creep behavior of electroplating nickel film was determined and characterized. Experimental results show that when the bending stress is smaller than the measured yielding strength, the relation between the stress and strain rates is expressed as: $(d\varepsilon/dt) = 0.00661n(\sigma) + 0.0104$. These test results can provide the basis for the design optimization of nickel microstructure. Thus the performance and reliability of the MEMS devices can be predicted and improved. [C2508]

"The paradigm of 'more than Moore'"

Microelectronics has pervaded our lives for the past fifty years, with massive penetration into health, mobility, security, communications, education, entertainment, and virtually every aspect of human lives. In the past

decades, as the main stream, these progresses are powered by Moore's law, with two focused development arenas, namely, IC miniaturization down to nano dimension, and SoC based system integration. While microelectronics community continues to invent new solutions around the world to keep Moore's law alive, there are ever-increasing awareness, R&D effort and business drivers to push the development and application of "more than Moore" (MtM) that are based upon or derived from silicon technologies but do not scale with Moore's law (with typical examples as RF, power, sensor and actuator, SiP, heterogeneous integration, etc.). This emerging trend is partially triggered by the increasing social needs for high level system integration including non-digital functionalities, the necessity to broaden the product portfolio of existing wafer fabs, and the limiting economic and time factors of advanced SoC development. Starting from the rationale of MtM, this paper will highlight some strategic research subjects for the major "MtM" related technology building blocks. Some issues related to the paradigm of MtM, covering industrial vision, strategy and business models, will also be discussed.

[C2509]

"Ceramic solid state lasers"

Modern ceramic technology made it possible to develop laser-quality and scalable full-transparent ceramic materials from nano-crystalline powder. The optical quality of ceramic materials is growing step-by-step. We have developed a modern technique for the laser quality ceramic materials. The Nd:YAG ceramics is already recognized as the real laser material for industrial lasers. They demonstrated high efficiency (optical-to-optical efficiency of 60%) and high power (1.7 kW) in cw mode. [C2510]

"Planning and Control for Automated Nanorobotic Assembly"

Nanomanufacturing using Atomic Force Microscopy has been widely investigated. Most of nanomanipulation schemes go through the scan-design-manipulation-scan cycle manually which is time consuming and inefficient. Automated AFM tip path planning is desirable for nanomanufacturing, but does not receive much attention. In this paper, a CAD guided automated nanomanufacturing system is presented. Based on the CAD model of a nanostructure, the manipulation paths for both nanoparticles and nanorods are generated automatically. A local scanning method is developed to compensate for the random drift that may cause the failure of the nano-assembly. The experimental results demonstrate that the developed algorithm can be employed to manufacture nanostructures efficiently. The research work opens a door to the CAD guided automated nanomanufacturing.

[C2511]

"Modeling and Control of AFM-based Nano-manipulation Systems"

This paper develops a model and control scheme for nano-manipulation systems based on atomic force microscopes (AFM). The model includes the micro-cantilever's and piezotube actuator's coupled dynamics. An identification-based controller is proposed for piezotube scanner positioning accounting for the piezotube's nonlinear sensitivity and axes coupling. A novel robust adaptive controller is developed to compensate for large parametric uncertainties including time varying and switching parameters due to probe-surface contacts as well as time varying and impulsive forces due to contact and impact. Discussions and simulations are presented for typical nano-manipulation tasks. [C2512]

"Towards Linear Nano Servomotors with Integrated Position Sensing"

Nanoscale linear servomotors with integrated position sensing are investigated from experimental, theoretical, and design perspectives. Prismatic motion is realized using the interlayer motion of telescoping multi-walled carbon nanotubes (MWNTs). Position sensing can be achieved by monitoring field emission or by measuring resistance change between a MWNT and a gold substrate during sliding movement. Experimental results demonstrate resolution in the nanometer range. Actuation experiments demonstrate the feasibility of a linear nano servomotor with integrated position sensing based on field emission. A local "kink"-like fluctuation of emission current is observed, which is caused by the change of the protruding length of the nanotube core, thus demonstrating the potential of using emission as a "linear encoder". Complete extension of the inner core is observed and the electrostatic force is calibrated to be tens of nano-Newtons for individual nanotubes— 13.3 to 23.3 nN for voltages from 20 to 30V. These results demonstrate the possibility of fabricating linear servomotors at the nanometer scale with integrated position sensing. [C2513]

"Functionalized Nano-Robot End Effector for in situ Sensing and Manipulation of Biological Specimen"

Atomic force microscopy is a powerful and widely used imaging technique that can visualize single molecules both in air and solution. Using the AFM tip as the end effector, it can be modified into a nano-robot which can manipulate objects in nanoscale. By functionalizing the nano-robot end effector with antibodies, atomic force

microscopy is able to identify specific types of receptors on cells' membrane in an image much as fluorescent tags do in optical microscopy but with higher resolution. After the single receptors have been identified, it becomes possible to manipulate these biological macromolecules in their physiological environment. This new technology opens a promising way to study the function of biological macromolecules individually. [C2514]

"Achromatic pi-phase shift for nano-sensing interferometry: nulling of polychromatic on-axial light, off-axial light detection"

Achromatic 180° -phase shift is demonstrated to null the polychromatic light emitted from on axial direction in order to detect the light emitted from off-axial source. Nulling of the polychromatic light over 300 nm bandwidth is shown by simple experiment. [C2515]

"Digital holographic microscopy, a new imaging technology applied to biological cells and tissues"

Digital holographic microscopy is a new imaging technique offering high resolution and real time observation capabilities. This new imaging approach is based on the coherent propagation of light in dielectric matter in general: biological objects in particular. The originality of our approach is to provide both a slightly modified microscope design, yielding digital holograms of microscopic objects and an interactive computer environment to easily reconstruct object shape from digital holograms at the nanoscale. Real time image reconstruction and rendering is henceforth possible, thus providing a new tool in the hands of nano-systems engineers and biologists. Direct imaging of cells and tissues structure. In vitro and possibly in vivo by the newly developed imaging technique is deemed to offer unique investigation means in biology and medicine [C2516]

"Second harmonic generation in reverse-proton-exchanged waveguides fabricated in periodically-poled stoichiometric lithium tantalate"

In this paper, we will examine second harmonic generation in buried waveguides created through reverse-proton-exchange in periodically-poled stoichiometric lithium tantalate. Waveguides of various widths were fabricated on a 2.5cm long SLT sample provided with 5 poling periods ranging from 17.7 to 18.5µm. The fabrication parameters were chosen according to the modelling guidelines recently proposed, in order to obtain single-mode propagation at 1.55µm with good fiber mode-matching. The proton-exchange was performed in pure benzoic acid at 280°C for 1h 45m, followed by annealing in air at 350°C for 3h. The burying step was achieved by a reverse-exchange process involving the immersion of the sample for 25h at 350°C in an eutectic melt composed by LiNO₃, KNO₃ and NaNO₃. The nonlinear characterization was performed by measuring the second harmonic generation efficiency as a function of the wavelength. [C2517]

"Wavelength Tunable Fiber Laser Technology for Optical Coherence Tomography"

Wavelength tunable laser has always been the key technology for wavelength-division multiplexing optical communication community, but few have realized that wavelength-swept laser has great potentials in biomedical applications. In this talk, the application of wavelength-swept fiber laser will be especially discussed for Fourier-domain optical coherence tomography source. Various wavelength-swept lasers are investigated using novel fiber-optic wavelength-selecting filters, such as polarization-maintaining fiber and acousto-optic Sagnac loop tunable filters. [C2518]

"Polarization controlled VCSEL with metal nano-structure for near-field optics"

We propose and demonstrate a novel approach for polarization control of a GaAs VCSEL using arrayed rectangular nano-apertures, which would enable us to achieve efficient optical near-field generation from a metal nano-aperture. [C2519]

"Dynamic growth process of W-nano-branched structure on insulator substrate studied with transmission electron microscopy"

Controllable fabrication of nanostructure is important and necessary to application of nanomaterials in technology. Among the methods of fabrication of nanostructures, electron-beam-induced deposition (EBID) is a promising method. A transmission electron microscope (TEM), JEM-2010F operated at 200 kV, was used for fabrication of nanowires and nano-branched structures. Thin film samples of SiO₂ or Al₂O₃ were used as substrates. Tungsten hexacarbonyl (W(CO)₆) powder was used as a precursor. The base pressure in column is lower than 2 × 10⁻⁵ Pa. A gas introducing system which has a nozzle with an inner diameter smaller than 0.1 mm and a reservoir of powder gas-source was used. The fabricated structures were characterized in-situ or after the fabrication with JEM-2010F TEM. All the experiments were performed at room temperature. Nanowires

in diameter of about 3 nm nucleate on surface of substrate after starting the electron irradiation with intensity lower than 0.75 A/cm². They nucleate and grow within the all area electron beam irradiated. They grow almost normally to the surface of the substrate with distances of several nanometers between each other. [C2520]

"Synthesis and properties of carbon nanotube arrays grown from sandwich catalyst stacks"

Carbon nanotubes (CNTs) are ideal field emission sources because of combining a high aspect ratio with chemical inertness, good electron and thermal conductivity and mechanical strength. A stable field emission current of 1 A from one multi-walled CNT and a high emission current density of 1 A/cm² from CNTs emitter arrays have been reported. Vertically aligned, sparse CNTs are proposed as being the ideal field emitters. Well-aligned CNTs have been made with hot filament chemical vapor deposition (HFCVD), plasma enhanced chemical vapor deposition (PECVD) and microwave plasma chemical vapor deposition (MWPCVD). However, up to now it is difficult to obtain CNT arrays with uniform and large current density, because of the strong field shielding effect due to the high density of these well-aligned CNTs. We report in this paper a method to grow CNT arrays, which are freestanding, well-aligned, and vertically-oriented. Furthermore, these CNTs have a uniform length and diameter. Growth has been realized at lithographically defined sites on metallic, semi-conducting and glass substrates. A sandwiched catalyst structure and MWPCVD is utilized to form multi-walled and also single-walled carbon nanotubes. Figure 1a) and 1b) is a scanning electron microscope (SEM) image of our as-grown CNTs using sandwiched catalyst structure. It is feasible to grow CNTs between two terminals directly, as shown in figure 1a), and grow straight vertical CNT bundles with small diameter of less than 2 nm, as shown in figure 1b). The transmission electron microscope (TEM) image of the as-grown CNTs shows typical multi-walled CNTs lattice structure with few defects, as shown in figure 1c). After treating the as-grown CNTs in a oxygen radio-frequency plasma, a highly stable field emission current density of more than 6 A/cm² at a electric field of 7.4 V/μm with a total field emission current of >600 A was obtained, as shown in figure 3. The work functions of the CNTs before treatment and after treatment were 4.56 eV and 4.0 eV respectively, measured by XPS. Our experiments indicate a fabrication route for largely improving the field emission characteristics of CNT-based field emitters. Further more, this new technology offers a simple and scalable pathway to create nano-sized electronic- circuits and devices with a 3D-structure. [C2521]

"Electron field emission from a single carbon nanotube: effects of anode location"

Electron field emission from an isolated carbon nanotube (CNT) were performed in-situ in a modified scanning electron microscope, over a range of anode to CNT tip separations, D , of 1 to 60 μm. The CNT was exposed from a CNT-polymer composite which was physically broken and examined along the broken edge. The threshold field required for an emission of 100 nA was seen to decrease from a value of 45 V/μm-1 at an anode to CNT tip separation of 1 μm, and asymptotically approaches 4 V/μm-1 at a separation of 60 μm. By defining the separation as $(D-h)$ rather than D , where h is the height of the CNT, our applied electric field is $E=V/(D-h)$. Calculation of enhancement factor using the Fowler Nordheim equation shows an increase in enhancement factor with an increasing D , and ties in well with the decrease in threshold field with increasing D . Under "far field" conditions, where $D > 3h$, the CNT enhancement factor is no longer dependent on D as shown by the asymptotic behaviour of threshold field, and is purely a factor of the CNT height and radius. Fowler-Nordheim analysis allowed calculation of the emission currents for given CNT to tip separation. The calculated emission current, threshold field and enhancement are comparable to that found experimentally. [C2522]

"Technology Platform Based On Comprehensive Device Modeling For RF SoC Design"

As the semiconductor industry continually drives our life into 21st century with increased productivity and improved convenience throughout the economy, both foundries and EDA vendors are heavily investing in developing the technology platform for nano-scale and RF technologies, in order to support the significantly increased demand for compact, low cost, and low power IC design. With a lot of fundamentals to be understood and a lot of technical barriers to be overcome in process technologies, device modeling advanced design methodologies, and system architecture, this technology platform is becoming crucial in providing an accurate and efficient design environment for RF SoC design. This paper will try to outline this technology platform and review in general device modeling and its role as a foundation of the advanced technology platform for RF SoC design. [C2523]

"Nanotechnology-enabled wireless sensor networks: overcoming the limitations from a device perspective"

The advancement of wireless communications and integrated circuit technology has enabled the development of low-cost sensor networks. The sensor networks can be used for various application areas (disaster recovery, health, military, homeland security, environment, home, etc.). For each application area, there are different

technical issues that researchers are currently resolving. However, many of them are trying to tackle the limitations of this field from a network perspective. Sometimes, the effectiveness of some proposed approaches must be complemented by the supports of hardware design. This article points out the possibilities of overcoming the same problem set from a device perspective by taking advantage of the merits of nanotechnologies. At the same time, open research issues and challenges are identified to spark new interests and developments in this field. [C2524]

"High performance conductive adhesives modified with molecular wires"

Different types of self-assembled monolayers (SAMs) were used to treat nano Ag fillers. Self-assembled monolayer (SAM) molecules wires can act as electrical junctions between the conductive filler of the ACA and the contact pad of the substrate, as such, the interfaces between the conductive fillers and contact pad could be enhanced. Thermogravimetric analyzer (TGA), differential scanning calorimeter (DSC), and contact angle results indicated the SAMs were well coated on the nano Ag particles. Furthermore, these molecular wire-treated ACAs were thermally stable at processing temperatures of the ACA samples. By introducing the novel molecular wires into the interfaces between nano metal fillers and the substrate bond pads, the conductivity and current carrying capability of ACAs were further improved due to the stronger bonding between nano fillers and SAM and consequently the improved interface properties of the high performance ACA for potential microprocessor applications [C2525]

"Bipolar Quantum Child-Langmuir Law"

Summary form only given. The classical Child-Langmuir (CL) law has been the subject of interest for many years. Since it was first derived in the early twentieth century, many modifications have been made recently to include multi-dimensional, relativistic, and quantum effects. Including the effects of ion flows, bipolar CL law for classical and relativistic theory has been developed. However, the scaling of bipolar flow in a nano-sized diode is still unknown. In this paper, we present a consistent quantum mechanical model of the bipolar CL law based on the mean field theory. In the model, we consider only the quantum effects for electron, but including the space-charge effects of ions consistently. From our calculations, we see that the classical bipolar CL law is no longer valid in quantum regime, when the effects of electron tunneling and exchange-correlation become important. Smooth transition between the classical and quantum regimes is demonstrated [C2526]

"Neuroprocessing through a new multi-device hybrid architecture"

The use of hybrid technologies creates the opportunity to combine nano-scale technologies, microelectronics and neuroscience in order to build devices for non-invasive stimulation and recording of cultured neural cells at nano-level. A hybrid neuro-electronic platform for neuroprocessing is proposed as a means to develop a new intelligent information system biologically inspired. The platform is designed to support both biological and artificial neural networks. In particular, in this work a hybrid system for culturing living cells has been designed that guarantees a reliable neuron-electrode connection and also their trapping inside the well; moreover the development of a digital artificial neural network of neurons has been designed and implemented by FPGA [C2527]

"Development of high performance photo-curable nanocomposites for electronics packaging"

A novel photo-curable nanocomposite material which can act both as a photoresist and a stress redistribution layer applied on the wafer level was synthesized and studied. In the experiments, the 20nm silica fillers are modified by silane coupling agent through the hydrolysis and condensation reaction and then incorporated into the epoxy matrix. A photo-sensitive initiator is added into the formulation which can release the cations after UV exposure and initiate the epoxy crosslinking reaction. The photo-crosslinking reaction of the epoxy makes it a negative tone photoresist. The curing reaction of the nanocomposites is monitored by the differential scanning calorimeter (DSC) with photo-calorimetric accessory (PCA). TEM picture shows the filler is well dispersed in the epoxy matrix; therefore the problems associated with filler agglomerations can be eliminated. The thermal mechanical properties of photo-cured nanocomposites thin film are measured. The addition of nano-size silica fillers not only reduces the thermal expansion and improves the mechanical property of the epoxy, but also has less influence on the optical property of the epoxy, which insures the occurrence of the photo reaction in epoxy [C2528]

"Bed of nails: fine pitch wafer-level packaging interconnects for high performance nano devices"

The rapid advances in IC design and fabrication continue to challenge electronics packaging technology in terms of fine pitch, high performance, low cost and better reliability. The shift towards the nano ICs with feature size less than 90nm, increases the demand for higher I/O count per integrated circuit (IC) chip. The demands for high

pin count and the increasing packaging density requirements in high performance device packaging is necessitating less than 100 microns pitch chip to substrate interconnection technologies. However, the long-term board level reliability of packages with large distance from neutral point (DNP) is not yet fully solved. Wafer level packaging is the promising solution to meet the cost and fine pitch requirements. Currently, the CTE mismatch between Si chip and substrate serves as the biggest bottleneck in the conventional chip-to-substrate interconnection technology and this becomes even more critical with reduction in pitch of the interconnects. Added to this, even the assembly yield of such fine pitch interconnections also serves as one of the other biggest challenges. In this paper, the bed of nails (BoN) interconnection technology on a 20 times 20 mm² test chip with 2256 and 36,481 I/Os in 3 depopulated rows and fully populated, respectively, are presented. This technology has been developed to achieve a fine pitch of 100 microns and high density interconnections. The test demonstrators are designed with same number of I/Os and fabricated. Compliance is also provided by giving high stand-off height of interconnect (> 2 aspect ratio) compared to the conventional solder bumping where the aspect ratio equals one. The board level reliability test is performed on the 20 times 20 mm² test chip with depopulated BoN interconnects, with and without underfill, under temperature cycling at the range of -400degC to 125degC [C2529]

"Formation of very fine pit and dot arrays using EB writing for ultrahigh density storage toward 1 Tb/in²"

Fabrication of ultrahigh packed pit and dot arrays have been studied using conventional electron beam (EB) writing, and positive and negative EB resists, ZEP520 and calixarene, respectively. Using fine electron beam with high probe current and very thinner resists, we demonstrate that the negative resist has a potential to achieve an ultrahigh density storage with both bit pitch (BP) and track pitch (TP) of < 30 nm and a dot diameter of < 15 nm, although the positive resist has a limitation at a BP of 60nm and a TP of 40nm. This dot array opens a way toward > 1 trillion bits per inch² (Tb/in²) storage technology. [C2530]

"Advanced Capacitor Development for Marxed Modulators"

Sci-Eng Solutions is developing advanced, high-energy density capacitors requisite to the demanding requirements of Klystron drive modulators in conjunction with the Stanford Linear Accelerator Center. Unique, nano-sized barium titanate and strontium titanate dielectric powders are used to fabricate high energy density ceramic capacitors. These crystalline ceramic powders have uniform spherical morphology and high dielectric constant, with sintering temperatures as low as 1000degC. The improved microstructure of the finegrained, sintered ceramic improves uniformity and reduces dielectric breakdown relative to equivalent, large grained ceramics. Moreover, various dopants or modifiers can also be used in binary compositions to tailor electrical performance for a wide range of applications. The size, purity and tailored compositions of the nano-powders result in a performance capability superior to convention ceramic technology; and the ultra-fine particle size makes these ceramic capacitors ideal for numerous modulator applications, such as directed energy weapons (high power microwaves and lasers), particle beam accelerators, high speed rail systems, lasers, and advanced radars. [C2531]

"A Ceramic Loaded Polymer Blumlein Pulser for Compact, Rep-Rated Pulsed Power Applications"

The design of compact pulsed power systems involves the trade between size, pulse length and pulse shape. A stacked Blumlein line with high dielectric constant material can deliver a voltage flattop to a matched load with an energy density similar to capacitor banks. By imbedding nano-scale titanate particles in an epoxy matrix, a composite material with a relative permittivity in the range of 30 to 60 may be realized without the drastic loss in dielectric strength associated with large area ceramics. So called ceramic loaded polymer dielectric employed in a Blumlein line facilitates the fabrication of a compact pulse forming line potentially suitable for driving loads of several tens of Ohms in the GW power range for greater than 100 ns. This paper describes the initial efforts to fabricate and test a parallel plate Blumlein incorporating ceramic loaded polymer dielectric. Two single-stage parallel plate Blumlein lines were fabricated with different ceramic loading. The lines were designed to yield a 50 ns pulse into a 6.25 Omega load. The Blumlein lines were designed to be charged to 62.5 kV, and both fabricated units held the charge voltage in static tests. A small railgap switch was fabricated for use with the Blumlein lines. A mid-plane knife-edge electrode was used to trigger the switch. The results of the tests are presented along with projections for the future development of this technology. [C2532]

"Developing design tools for biological and biomedical applications of micro- and nano-technology"

This short paper, an update of [75], is intended to provide a brief summary and extensive references on biological applications for micro- and nano-machining, as well as the computer-aided design challenges generated by those applications. [C2533]

"Observation of Pulsed Streamer Discharges Produced by Nano-Second Pulsed Power in Atmospheric Air"

Pulsed power technology has been used in many applications such as control of NO_x and SO_x from exhaust gases, treatment of dioxins, removal of volatile organic compounds, and generation of ozone. Since the pulse width of the applied voltage has a strong influence on the energy efficiency of the removal of pollutants, the development of a short pulse generator is of paramount importance for practical applications. The observation of discharges created by short duration pulsed voltage is an essential aspect for understanding the plasma physics of this growing field. In the present work, a nano-second pulse generator (NS-PG) that has a pulse duration of less than 10 ns is presented. The NS-PG consists of a high-pressure spark gap switch as a low inductance self-closing switch and a triaxial Blumlein line as a pulse-forming line. The Blumlein line consists of an outer conductor, a middle conductor, and an inner conductor, and is filled up with transformer oil as an insulation medium. The outer conductor is grounded, and the nano-second pulse is generated between the inner and outer conductors. The characteristics of the NS-PG are also reported. The propagation images of the pulsed streamer discharge in a coaxial reactor were taken by a high speed streak camera. The propagation of the streamers was observed for both positive and negative polarities of the applied voltages to the reactor. From the results, for both polarities, the primary streamer propagated from the inner wire electrode to the outer cylinder electrode, and the maximum propagation velocity of the streamer was in the range 6.0-8.0 mm/ns over the voltage 67-93 kV of the absolute value of peak applied voltage. The results also showed that the propagation velocity of the streamers was strongly influenced by the voltage rise time and to a lesser extent by the voltage polarity. [C2534]

"Robust Control Framework for Piezoelectric Actuation Systems in Micro/Nano Manipulation"

Micro/nano manipulation has been identified as one of the key enabling technologies for many emerging challenges. Within this scope, piezoelectric actuators have played major roles in achieving the required nano-resolution motion. This paper proposes a robust control framework for piezoelectric actuation systems to follow specified motion trajectories. The basic concept associated with this methodology lies in the specification of a target performance and the robust control scheme formulation for piezoelectric actuation systems to ensure the convergence of the position tracking error to zero. This control methodology is attractive as its implementation requires only the knowledge of the estimated system parameters and their corresponding bounds, including bound of hysteresis and external disturbances. Feasibility study of the framework for piezoelectric actuation systems in micro/nano manipulation is described. Simulation results validated the suitability of the proposed control approach. [C2535]

"A Capped Trimming Hard-Mask Patterning Technique for Integration of Nano-Devices and Conventional Integrated Circuits"

Capped trimming hard-mask (CTHM) patterning technique has been developed based on standard materials and processing equipments. By using the CTHM technique, sub-50nm feature sized pattern can be realized based on 0.5μm lithography technology. Imaging layer for capping and hard-mask layer should have different etching selectivity and good contiguity to each other. Good control of trimming etching and hard-mask etching processes enable patterning of features with ultra-small dimension. [C2536]

"Fabrication and Electrical Characteristics of AgTCNQ Crossbar Switches for Organic Molecular Memories and Logics"

The 8x8 crossbar switches with sandwiching AgTCNQ (TCNQ = 7,7,8,8-tetracyano-p-quinodimethane) organic molecular materials were successfully fabricated, and electrical characteristics of the cross points were studied in this paper. In the OFF state, the resistance of switches was 5.60x10³ohms that stands for "0"; while in the ON state, the resistance of switches was 1.96x10³ohms that stands for "1". This phenomenon was simply interpreted based on phase transition caused by charge transfer. The switches could be used for memories as well as electrical configurable logic gates, such as an AND, an OR and even an NOT gate. [C2537]

"A Nanocore/CMOS Hybrid System-on-Package (SoP) Architecture for Future Nanoelectronic Systems"

Recent results showed that when the minimum feature size used in semiconductor device fabrication moves to sub nanometre scale, several physical and economic limits jeopardize the device behaviour, binary logic, and the lithography techniques currently used. To surpass this "brick-wall" and continue the Moore's law forever, novel nano-electronic devices are becoming more popular and promising. But, interconnecting nano-devices into complex electronic systems has not yet been demonstrated. In this paper, the authors propose a nanocore/CMOS hybrid system-on-package (SoP) architecture which is suitable for any emerging

nanotechnology [C2538]

"Nano-machining Experiment of Metal Materials Polishing with Ice Desk"

Nano-level smooth surfaces are used more and more in high and new technology production, and requirement of them is higher and higher. Traditional polishing methods keep the surface roughness from further reduction because of the existing of abrasive materials. Nano-machining polishing on metal materials with ice desk is an originality innovation polishing method. Polishing desk is made of ice desk without abrasive materials, so nano-level surface roughness can be obtained. This paper makes some systematic researches on nano-machining polishing method on metal materials with ice desk. The paper proposes the experiment equipment that can realize the ice desk polishing on metal materials and the preparation of ice desk, work piece plate in detail. This paper also discussed the machining techniques of ice desk polishing and the disposal and measurement on work piece after machining. Metal materials polishing experiment are carried on with different kinds of water and pressure of press head. The water and pressure of press head which are best suitable for metal materials polishing experiment are obtained. Influential regularity of polishing metal materials is studied with different ice desk speed and work piece plate eccentricity. Based on theories of surface interface and metal fabric, from atomic and molecular level, microcosmic elimination mechanism of metal surface materials and variety of work piece surface roughness in ice desk polishing nano-machining on metal materials are discussed and analysed primitively [C2539]

"Glass transition effects in ultra-thin polymer films studied by dielectric spectroscopy-chain confinement vs. finite size effects"

Polymers in confined environments show deviations from their bulk-properties, i.e. various size effects, due to the interference of intrinsic length scales with the dimensions of the imposed geometry. A solid understanding of the structural and dynamic properties of polymers in confined geometry becomes more and more a prerequisite for the successful use of polymers for nano-structured functional materials, cellular electrets and thin film processing for the microelectronics technology. This paper deals with effects of geometric confinement on the dynamics, particularly the glass transition dynamics of ultra-thin polymer films for which spectacular glass transition reductions up to 70 K have been reported, usually based on dilatometric techniques. Here we have employed dielectric relaxation spectroscopy (DRS) that was successfully applied to ultra-thin films (3 gin ultra-thin polymer films: i) The "true" finite size effect that originates from the breakdown of cooperative motions for L EE(end-to-end distance). [C2540]

"New course on computational platforms towards nanoscale systems"

In this paper we present an educational approach for a paradigm shift needed when changing from deep submicron CMOS designs to real nano and nanoscale technologies (Waser, 2005) in complex communication and computation system implementations. Here we present an introduction course implemented for starting the paradigm shift in curriculum. Here we present course targets, structure and implementation as well as future designer competence profiles. The course is consisting of five thematic areas: nanoscale technologies, parallel platforms, concurrent algorithms, reconfigurable systems and autonomous system management. These thematic areas compound the core of future nanosystems educational program upgrades for current NoC curricula. [C2541]

"Inkjettable conductive adhesive for use in microelectronics and microsystems technology"

Ink jet is an accepted technology for dispensing small volumes of material (50-500 picolitres). Currently traditional metal-filled conductive adhesives cannot be processed by ink jetting (owing to their relatively high viscosity and the size of filler material particles). Smallest droplet size achievable by traditional dispensing techniques is in the range of 150 μm , yielding proportionally larger adhesive dots on the substrate. Electrically conductive inks are available on the market with metal particles (gold or silver) < 20 nm suspended in a solvent at 30-50 wt%. After deposition, the solvent is eliminated and electrical conductivity is enabled by a high metal ratio in the residue. Some applications include a sintering step. These nano-filled inks do not offer an adhesive function. Work reported here presents materials with both functions, adhesive and conductive. This newly developed silver filled adhesive has been applied successfully by piezo-ink jet and opens a new dimension in electrically conductive adhesives technology. The present work demonstrates feasibility of an inkjettable, isotropically conductive adhesive in the form of a silver loaded resin with a 2-step curing mechanism: In the first step, the adhesive is dispensed (jetted) and precured leaving a "dry" surface. The second step consists of assembly (wetting of the 2ndpart) and final curing. [C2542]

"Micro and nano fluidic chips for biosensors"

Micro and nanofluidics provide very controlled delivery of reagents and samples for highly sensitive biosensors. Two fluidic platforms are introduced in this paper, the microfluidic droplet emulsion and the electrical field-based microfluidics. Traditional issues in microfluidics such as mixing in low Reynolds numbers can be mitigated using some of our active microfluidic techniques [C2543]

"0.8V 1GHz dynamic comparator in digital 90nm CMOS technology"

The design of a 0.8V 1GHz dynamic comparator in digital 90nm CMOS technology is presented. The work shows that low voltage, low power and high speed analog circuits are feasible in nano-scale CMOS technologies. The dynamic comparator dissipates a maximum of 222 μ W at 1 GHz clock frequency with 100fF capacitive load and 0.8 V supply voltage. This is lower than comparable results. [C2544]

"Organic Semiconductors Providing New Solutions for Future Medical Implants"

Although implantable medical microsystems like painkillers, deep brain stimulators and the promising cochlear implants, have reached a high degree of reliability and usability for the patient, the implementation of neural stimulators with hundreds or thousands of microelectrodes still suffers by the interconnection problem between the electrode array and the electronic stimulator device. A mechanically flexible interconnection of all electrodes of a large 2D-electrode array to a monolithically integrated stimulator/recorder device is almost impossible, since the integrated circuit can only be attached using either bumps or bonds. In this contribution, the usage of organic semiconductors for the implementation of an addressable active stimulator cell is proposed to overcome these limitations. This stimulator electronic can be fabricated either with printable long chain organic semiconductors or, as described here, with short chain semiconductors (oligomers) like pentacene. The mechanical flexibility of arbitrarily sized and shaped 2D multicontact array is completely preserved, if this flexible semiconductor electronic is interlaced between the electrode rows and columns. [C2545]

"Manipulation using 3-D nano-manipulator fabricated by FIB-CVP in the nano-factory"

We will report on the movement characteristics of the 3-D nano-manipulator fabricated by FIB-CVD and the manipulation of nano-parts with various structures and materials by using the 3-D nano-manipulator in the nano-factory. [C2546]

"Electromagnetic induction phenomena of nano-coil fabricated by FIB-CVD"

In this paper, we have demonstrated the observation of electromagnetic induction between two coils. Two nano-coils were fabricated extremely close to each other on electrodes by FIB-CVD. The SEM image of two nano-coils fabricated by FIB-CVD is shown. Phenanthrene (C₁₄H₁₀) source gas was used to make DLC coils. [C2547]

"Electrically Conductive Formulations Filled Nano Size Silver Filler for Ink-Jet Technology"

As current studies and analyses imply, the future of modern microelectronics solutions is utterly dependent on nanotechnology within which nano size materials are more and more frequently produced and applied. This results in the unparalleled possibility of creating new, so far impossible to manufacture products as well as application technologies. Consequently, this results in a significant increase in the possibility of miniaturization of elements of electronic systems by reducing the dimensions of its elements themselves as well as increasing the density of their compaction. Polymer composites containing silver particles of single nanometers (several atoms) may be printed with the application of the Ink-Jet method in order to obtain a line or 'points' being electricity conductors or contacts in electronic assembly. The Ink-Jet printing method utilizes the percussive effect of a piezoelectric compressing capillary element within microsecond and thus resulting in sudden 'expenditure' of the dosed composition. During the very dosing process, the dosed portion is affected by acceleration of 105g, which may cause separation of elements of various specific weights from the dosed composition. Therefore, the physically best composition has the features of a specific solution in which the filler conducting electricity (silver) has the dimensions insignificantly differing from the dimensions of the binder in which it is 'suspended'. One of the crucial technical problems is the production of silver particles separated from one another and of adequately small and repetitive at defined time dimensions. [C2548]

"Emerging Reliability Issues of Nano-Scale SOI Technology"

In this review, the following reliability concerns: hot carrier reliability, negative-bias temperature instability (NBTI), time depended dielectric breakdown (TDDB) and electrostatic discharge, are discussed individually, and recognizing that the responsible mechanisms quite often are active simultaneously, their interdependence and interaction is also discussed [C2549]

"High-yield fabrication of AFM probes with simultaneous formation of both nano-tips and cantilever"

Presented is a new micromachining technology for high-yield fabrication of silicon AFM probes. Both tips and cantilevers are simultaneously formed with a masked-maskless-combined anisotropic etching process. The cantilever contour is firstly formed by masked etching. Then, the SiO₂ etching mask is removed while the mask for tip-contour formation is remained. Following the combined etching is performed with the cantilever dived to the bottom of the SOI active layer by maskless etching. Simultaneously, cone-shaped tip contour with about 0.5 μm top-diameter is formed by convex-corner undercutting of masked etching process. By specific design based on the rules of the masked-maskless combined etching, the cantilevers and the tips are simultaneously formed. Compared with previous tip-to-cantilever sequential fabrication scheme, this simultaneous formation can effectively increase fabrication yield by avoiding the tips damaged during the process. In addition, the low-cost and mass-producible fabrication techniques, such as anisotropic etching and thermal oxidization, are used instead of expensive and difficult-controlled technique such as the combination of anisotropic and isotropic RIE, etc. Higher than 80% fabrication yield for the AFM probes has been realized in 4-inch wafers. The final tips after oxidation-sharpening treatment are generally with a radius of about 10-30 nm and the cantilever spring constant can be well controlled. Sample scanning results from the AFM probes are demonstrated to provide high-resolution image, whose quality is comparable with those from commercialized probes [C2550]

"A new nano-electro-mechanical field effect transistor (NEMFET) design for low-power electronics"

An accumulation-mode design for nanometer-scale electromechanical-gate field effect transistors (NEMFETs) is proposed and studied via simulation. In the off state, the gate electrode is in contact with the thin gate dielectric and short-channel effects are effectively suppressed. In the on state, the gate electrode is separated from the thin gate dielectric so that the threshold voltage V_T is dynamically lowered and the transistor drive current I_{on} is enhanced, and gate leakage is eliminated. The NEMFET can likely meet performance specifications for low-power applications at 25 nm gate length, and is attractive for scaled supply voltage operation [C2551]

"Fabrication of 3D trench PZT capacitors for 256Mbit FRAM device application"

We fabricated trench PbZr_xTi_{1-x}O₃ (PZT) capacitors that can be used in 256Mbit 1T-1C FRAM devices. The capacitor has 0.25 μm diameter and 0.4 μm depth. Three layers, Ir(20 nm)/PZT(60 nm)/Ir(20 nm), were deposited in SiO₂ trench holes by ALD and MOCVD. Both columnar and granular grains were formed on the sidewalls of the trench capacitors, and their relative portion had strong size dependence. The trench capacitors with more columnar PZT grains showed good switching behavior under 2.1 V external bias and 19 to 24 μC/cm² remnant polarization [C2552]

"Damage-free neutral beam etching technology for high mobility FinFETs"

Our newly developed neutral beam (NB) etching accomplished the damage-free (defect-free and smooth surface) fabrication of high aspect rectangular Si-fins for the first time. The fabricated FinFETs realized higher device performance (higher electron mobility) than that using a conventional reactive ion etching. The improved mobility is well explained by the NB etched atomically-flat surface. Our new results strongly support the effectiveness of the NB technology for the nano-scale CMOS fabrication [C2553]

"On-chip charge pumping method for characterization of interface states of ultra thin gate oxide in nano CMOS technology"

For the first time, on-chip charge pumping method is proposed to characterize ultra thin gate oxide for nano-scale CMOSFETs. Designed on-chip charge pumping system can supply 30-500 MHz square-type pulse waves to DUT transistor and measured charge pumping current showed no gate tunneling current dependency which can be easily monitored in very thin gate oxide. In addition to the measurement of interface states by fixed-amplitude method, the distribution of interface states in channel region can be easily extracted by fixed-base method using this system. The proposed method is also successfully applied to analyze hot-carrier stress-induced threshold voltage (V_t)-degradation and to evaluate plasma process induced damage in terms of interface trap density [C2554]

"45-nm node CMOS integration with a novel STI structure and full-NCS/Cu interlayers for low-operation-power (lop) applications"

We describe the integration of a 45-nm node CMOS for low operation power (LOP) application. The SD extension profile along with a strain channel and a thin-gate-SiON were optimized to keep high drive current at the 45-nm node. A novel STI structure was developed to reduce the SRAM cell size. Nano-clustering silica

(NCS) without a middle-etch stopper (MES) was also developed to decrease the wire capacitance. As a result, we achieved an excellent LOP device operation with conventional processing, and we produced a 50% smaller SRAM cell-size as compared to the 65-nm node [C2555]

"A MEMS resonant strain sensor with 33 nano-strain resolution in a 10 kHz bandwidth"

In this paper the authors demonstrate a high performance strain measurement system that consists of a polysilicon double ended tuning fork (DETF) resonant sensor and surface mount electronics to measure its output. This system achieves a resolution of 33 nano-strain (nepsiv) in a bandwidth of 10 kHz, and has a noise floor of 60 pico-strain per root hertz (pepsiv/radicHz) up to 1kHz. The 60 pepsiv/radicHz noise floor is equivalent to a displacement resolution of 12 femto-meters per root hertz (fm/radicHz). To the best of the author's knowledge the smallest reported displacement resolution using surface micromachining is 16 fm/radicHz (Geen et al., 2002) [C2556]

"Atto-liter periodical cavities for optical molecular detection"

A process technology for fabrication of high quality nano-hole arrays in thin gold layers on glass substrates, suitable for biomolecular applications is presented. Making use of a bi-layer resist system, electron-beam lithography and a lift-off technique, different arrays of square-shaped nano-holes have been obtained. The holes dimensions are between 100nm and 200nm, with different lattice constants in each case. The arrays were furthermore optically characterized, showing uniformity and increased intensity of the out-coming light [C2557]

"Effects of hot carrier stress and oxide breakdown on RF characteristics of MOSFETs"

Effects of hot carrier stress and oxide breakdown on the main figures-of-merit of RF MOSFETs are examined in this paper. We found that the degradations of cutoff frequency and power performance after hot carrier stress are larger than that after oxide breakdown. However, the minimum noise figure degradation is more significant after oxide breakdown. Those observations are important and should be concerned when designing an RF front-end circuit. [C2558]

"Nano-level 3-D shape extraction of precise parts using combination of multiple wave-length lasers"

To improve the productivity of very large scale of LSIs or large LCD panels, not only the technologies to inspect the LSIs or the LCDs but to repair them are required. To remove the less than one-micrometer contaminants on the LSIs, it is required to extract their 3-D shape, precisely. To meet with these requirements, a nano-level 3-D shape extraction method has been developed. Here, the basic idea of the method and the simulation result are described. To extract a nano-level 3-D shape, the method using some interference images is effective. Interference image is produced by light reflected by LSI and light, which is not reflected by LSI. At this time, if the light, which is not reflected by LSI, is changed at regular intervals, the brightness of same coordinate of interference images change like a sine wave. When each heights of LSI differ between coordinates, the brightness of interference image differs. And the phases of brightness pattern differ according to height between each pixel. To measure heights from these phases, the pattern matching method was used and compared it with template images. The algorithm and system to process at the same times it taken in interference images is described. Also, to meet with the requirement to measure more than wave-length, the combination method of multiple wavelength lasers has been introduced. It enables to measure 100 um height differences with nano-level accuracy [C2559]

"An Investigation of Femtosecond Laser Micromachining"

Femtosecond laser micromachining is a new approach emerging in MEMS area in recent years. Although some applications have been reported, this technology is still not matured and not understood very well. Femtosecond lasers currently show much promise as potential effective tools in micromachining or micro-system applications, which include industrial material processing, biomedicine, photonics and semiconductors. In this paper, the status of micromachining with femtosecond pulses is reviewed. Some of advantages and applications are presented. Finally, we propose a "free force" 3D micromachining concept using laser including femtosecond laser to create micro and nanostructures. [C2560]

"Microbolometer instrument payload design for a microsatellite mission"

This paper describes the design of the mission and the instrument. It compares the use of microsatellites, ground and air based platforms. An Earth observation microsatellite mission is based on microbolometer technology. The detectors are linear arrays, filtered to be sensitive in five bands: 3 bands between 8.5 and 12.5 microns, and 2 bands between 3.0 and 4.5 microns. It is expected that this Earth observation satellite will

produce useful dates like ice-shelf formation/melt, cloud monitoring, oil spills, forest fire tracking and damage assessment, Kyoto Accord compliance monitoring, city heat bloom, temperatures of oceans, land, and ice with the focus on northern coastal waters, Arctic and sub-Arctic land areas. Hence, satellite-based sensors have more advantages over terrestrial or airborne sensors. [C2561]

"RF MEMS for low power wireless communications"

RF MEMS (radio frequency micro-electro-mechanical systems) is a relatively new technology which has allowed the development of very low loss and highly linear switches and varactors, tunable circuits, and very high-Q (>5000) silicon resonators. The applications are many, from switching different antenna modules or different filters for a quad-band telephone, to very low phase noise 19 MHz reference oscillators built entirely in silicon and with no external crystals, to tunable impedance circuits placed between the power amplifier and the antenna for maximum efficiency. Currently, there are several technologies which have achieved >100 billion cycles of operation (for switches), and very low phase noise oscillators (for oscillators). The talk will summarize the latest development in the field, show possible field of use in multi-band tele-phones, and discuss the practical aspects of this technology (packaging, cost, reliability). [C2562]

"Study on the preparation and electro-deformation of EVOH-SO3 K IPMC"

EVOH-SO3K is prepared by sulfonation reaction of EVOH with 1,3-propane sultone and characterized by IR, ¹H NMR. It is soluble in water when the ratio of hydroxyl in EVOH and 1,3-propane sultone is less than 2.5 and insoluble in water when the ratio is more than 2.5. The EVOH-SO3K membrane is prepared by electrospinning and the electrode-formation characteristic of the membrane is studied. It is proved that there is electro-deformation on EVOH-SO3K film under the electric strength of 156-128 V/mm. The mechanism of electro-deformation is discussed according to the structure and the performance of the material. [C2563]

"Nano-satellites, a fast way to pre-qualify new micro-technology"

Micro systems technology and micro-electronics for space applications can draw great advantages from fast pre-qualification in a real space environment. This is true for technology in general, but probably even more so for these new technologies. Nano-satellites with a mass of 1 to 3 kilograms may provide such a test environment at acceptable cost. In addition they provide an opportunity for close co-operation between industries, institutes and universities, and allow also for active involvement of students in mission, hardware and software design and development during their studies. This paper discusses such an approach and illustrates it by means of a two-year project, Delfi-C3, of the Faculty Aerospace Engineering (AE) and the Faculty Electrical Engineering, Mathematics and Computer Sciences (EEMCS) of Delft University of Technology in the Netherlands. The project is executed in co-operation with Dutch Space and TNO Science & Industry, which supply two of the payloads flown. [C2564]

"New world in soft-nano-materials"

Nanotechnology was chosen as one of the important area of research together with life science, information technology and environment science. The nanotechnology research is not only focused on silicon nanotechnology but also on the ensembles of molecules that can be categorized as "soft nanomaterial". In this article giant clusters of aromatic molecules such as naphthalene and anthracene with clustering number beyond 100 were synthesized. By using the photoelectron spectroscopy of size clusters, crystalline-like ordered and liquid-like disordered states coexist. The goal of the project is a "synthesis of novel biofunction". The project is aimed at establishing a new science field where one could discuss biofunctions such as information transfer, self-organization and it is still under research. [C2565]

"Next generation microbolometers for high resolution remote sensing"

We describe our recent work on improving the time constant and NETD of uncooled microbolometer detector. Such improvement would enable infrared remote sensing with a spatial resolution better than 150 m from low earth orbits. Radiometric simulation of the new microbolometer designs shows that reduction of time constant by a factor of 3 and reduction of NETD by a factor of 1.5 can be achieved. Linear arrays of 512x3 microbolometers embedding the new designs have been fabricated for experimental validation. [C2566]

"The Dutch MST program MicroNed and its cluster MISAT"

The Netherlands wants to become a strong knowledge intensive economy. For that reason the government initiated "Besluit subsidies investeringen kennisinfrastructuur" (BSIK) which is aiming at investments to improve and strengthen the knowledge infrastructure of the Netherlands in general. Within the context of BSIK a program

called "MicroNed" has been proposed in the knowledge area microsystems- and nanotechnology. The research described in this paper is concerned with a micro systems technology (MST) based micro satellite called "MISAT" which forms part of the MicroNed program. The MISAT proposal consists of a bus, payload, architecture and formation flying work package. [C2567]

"Advanced microphotonic and MEMS technologies for the MEOS microsatellite Earth observation mission"

Infrared spectroscopy is a vital component of various Earth observation and planetary exploration space missions. It probes the characteristic vibrational modes of chemical bonds in molecules to provide information about not only the chemical composition but also the local bonding configuration and environment of the chemical bond. In particular, infrared spectroscopy has been employed to study atmospheric processes and various gas distributions. To date, mainly large bulk-optic Fourier transform (FT-IR) spectrometers employing variations of the Michelson interferometer, and massive high-order dispersive spectrometers have been employed in space for atmospheric studies on large and costly satellite platforms. In the following paper, we discuss the use of advanced optical coding and signal processing techniques to enable high-performance infrared spectral measurements of atmospheric components using MPB's miniature IR waveguide spectrometer. The miniature size of the spectrometer enables several dedicated spectrometers to be accommodated on a single microsatellite to extend the measurements that are feasible. In particular, these advanced technologies are being employed as the basis for the development of the use of the MEOS micro Earth observation mission. [C2568]

"The use of microelectromechanical systems for surge detection in gas turbine engines"

Compressor surge results from the instability of highly undesirable oscillations occurring at specific frequencies and at low compressor flow rates in the system. Research has shown that by stabilizing the small-perturbation dynamics, the large-amplitude surge event can be prevented in these systems. In order to completely avoid the initiations of conditions that will lead to surge or stall, engine designs conservatively determine operational stability margins that are far from the stability limit of the compression system. Advanced turbine engines operate with reduced stability margins to increase performance. This reduction in stability margin must be limited to such an extent that does not compromise the operational capability of the engine. Pressure probes equipped with fast-response transducers have been successfully used in axial-flow compressors and turbines but have been rarely used in centrifugal compressors. The harsh thermal environment of operation has limited the use of pressure transducers to operational ranges below 250°C effectively precluding measurement at the final stage exit where temperatures are typically in excess 280°C depending on the turbine. This paper proposes a hybrid processing method in which a piezoresistive chromium strain gauge is embedded between two thin film silicon carbide (SiC-MEMS) or silicon carbon nitride microelectromechanical (SiCN-MEMS) membranes as an enhanced technique for the design of high temperature pressure transducers. The hybrid process technology, which enables fabrication of such structure, along with the novel packaging principles represents the main contribution of the present report. [C2569]

"Investigations on nonvolatile and nonrotational phase change random access memory"

In this work, phase change random access memory (PCRAM) was studied theoretically and experimentally. Phase change materials were deposited and their physical parameters were measured. A simulation and design software for PCRAM was developed based on multidisciplinary theories including electrodynamics, thermal conduction, crystallization kinetics and numerical computations. By introducing physical models of PCRAM elements, a general macromodel of the phase change random access memory (PCRAM) elements for HSPICE-based computer simulator is proposed. PCRAM array were designed, fabricated, and tested by using a self built tester. Also, near field optical scan microscope incorporated with fs laser was used to fabricate nano scale PCRAM cells [C2570]

"Hysteresis spring single digital input bistable mechanism"

This paper presents the first reported microfabricated single digital input bistable MEMS mechanism. The bistable mechanism is an important building block for many MEMS. Applications of bistable mechanisms include optical switches, microrelays and motor transmissions. Current literature contains examples of dual digital input and single analog input bistable mechanisms; however, no single digital input bistable mechanisms have yet been reported. This work develops the hysteresis spring as an enabling mechanism to allow the creation of the first reported single digital input bistable mechanism. The functionality of the hysteresis spring single digital input bistable mechanism is described and an analytical model is developed. The analytical model is shown to agree with experimental results. The proof of concept design has been fabricated and the prescribed functionality has

been shown experimentally. [C2571]

"Towards a molecule-computer? Resources and technologies to compute within a single molecule"

The seminal Aviram-Ratner paper in 1974 had triggered the interest on a future molecular computer technology. In this direction, the first step is to realize a digital logic function with a molecule (Joachim, 2000). This requires (1) specific design rules depending on the semiclassical or quantum version of the logic function, (2) specific molecules with an internal board ensuring the function, (3) the board must be equipped with different chemical groups to ensure the portability of the function and its interconnection to users, (4) an atomic scale technology to secure user-molecule data & synchro signals exchange, the so-called nanocommunication problem. Finally, (5) production may not be solid state like as compared with micro (and nano)-electronic because of environmental concerns (Khuer and Williams, 2003). We review all those steps providing the state of the art in each case.

[C2572]

"Silicon nano-photonics: where the photons meet the electrons"

It has become apparent that silicon technology can provide many of the requirements for nanophotonic integration, including many of the common discrete optoelectronic components. Some of these components are based on photonic crystal designs, but generally electromagnetic design becomes the main research requirement in nano-photonics. The question has always been what is the exact structure that should be fabricated? The era of purely intuitive design may be obsolete. We must now concentrate more on design software, rational design, and the numerical solution of inverse problems. There are a number of inverse algorithms, including genetic algorithms, the error-propagation method, and simulated annealing that can contribute to future progress in nanophotonic design. [C2573]

"Self assembly-promises and challenges"

This paper surveys the field of self-assembly particularly in designing MEMS/NEMS system where many individual devices work together without central control to achieve a desired end. It illustrates both the promises and challenges ahead. [C2574]

"High-speed dense channel fiber Bragg grating sensor array for structural health monitoring"

Sensors for strain measurement are indispensable for structure monitoring. Fiber optic sensors based on Fiber Bragg Grating (FBG) technology are found to be suitable for strain sensing and have a number of advantages compared to conventional strain gauges. TNO has developed a high-speed detection system for FBG sensor array. The maximum sampling frequency of about 20 kHz is essential for modal analysis, noise reduction, impact detection and dynamic load measurement. In particular the latter is of importance for Structural Health Monitoring of composite structure. Different types of test are performed using this system. [C2575]

"Multiplexed fiber Bragg gratings for potential aerospace applications"

Fiber optic sensor technology continues to be one of the leading technologies with significant potential for integration into existing and emerging aerospace platforms and systems for advanced in-situ diagnostics, prognostics, health monitoring and management. For the past few years, this technology has witnessed significant development but continues to be limited to trial studies on legacy aircraft. To exploit the full benefits of this promising technology in developing an integrated airframe condition-based maintenance system, several challenges need to be addressed. A major one is the development of lightweight, small size, reliable, robust handheld multisensor interrogation system. This paper highlights our current fiber optic sensor capability; identifies current implementation challenges on aerospace platforms and presents a proposed state of the art alternative. This alternative uses an arrayed waveguide gratings (AWG) based demultiplexer and provides a system resolution of 0.1°C and 1µε for temperature and strain monitoring, respectively, in addition to the added benefits of weight and size. [C2576]

"Detection of encephalic and hemorrhagic viruses: integration of micro- and nano-fabrication with computational tools"

This document present an overview of the use of microarray technology, quantum dots, nanowires and carbon nanotubes to detect pathogens, in particular encephalic and hemorrhagic viruses. The relevance and challenges in the development of detection nanosystems and their integration with computational analysis tools and viral evolutionary genomics techniques are highlighted. [C2577]

"III-V compound semiconductor nanotechnology for smart systems"

Presents and discusses a new smart chip called an "intelligent quantum (IQ) chip". III-V semiconductor chips with sizes of millimeter square and memories are integrated on chip with capabilities of wireless communication, wireless power supply and various sensing functions. It is an attempt to endow "more intelligence" than simple identification (ID) like in RFID chips to semiconductor chips. A key issue to realize IQ chips is the power consumption of processor/memory parts which increases as one tries to endow more intelligence. The power density of the current Si CMOS technology is too high. Thus, use of quantum devices should lead to large reduction of power density. [C2578]

"Micro systems technology: the way to shrink sun sensors"

High reliability sun sensors are currently built using silicon detectors and aperture masks which are supported at an accurate distance above the sensitive detector surface. By using micro systems technologies like bulk and surface micro machining and wafer level bonding, highly precise and accurate sensors can be devised that are expected to have comparable performance but much smaller dimensions and mass. [C2579]

"Spin-transfer induced switching in magnetic nanopillars"

Summary form only given, as follows: the author reviews the basic experimental findings of spin-induced magnetic switching in sub-100 nm magnetic nanopillar spin valves. Issues include the basic physics of a spin-current-induced torque on a nanomagnet, sample fabrication techniques, and device properties in terms of current-induced magnetic excitation and magnetic switching dynamics. Potentials for future applications in magnetic memory technology and related challenges will also be briefly discussed. [C2580]

"Development of fabrication and detection system for centrifugal force and thermal management biochip"

The development of micro-electro-mechanical systems (MEMS) advances the success of microfabricated devices, and microfabricated devices offer many specific platforms that can integrate a laboratory on a chip and manage micro biochemical reaction analysis. Nevertheless, most microfabricated devices, especially in biochip design, depend on semi-conductor or LIGA process so that the configuration of devices is complex and money-consuming. Furthermore, miniaturization in nano-scale isn't always significant in bio-medical reactions. Thus, the aim of our research is to develop a fabrication and detection system of centrifugal-force and thermal management biochip, which improves the complex pumps and valves designed by semi-conductor application in lab-on-a-chip, and it saves time and money in the comparison of traditional lab technology. Our system uses the soft-ware-SolidWorks and computer numerical control (CNC) machine to design microfluidic patterns, the heat pressure machine with feedback control of temperature sensor to design the hermetically sealed biochip, and the centrifugal machine with server frequency conversion motor to lead sample mobility by centrifugal force instead of pumps and valves. The hardware of this system includes three parts: centrifugal machine, heat pressure machine, and microfluidic fabrication; the application of the biochip is to detect clinical and medicine bio-reactions. Our "fabrication and detection system for centrifugal-force and thermal management biochip" developed in this study is a on-table facility and can use in several areas of medical and clinical examinations, it can also combine with polymerase chain reaction (PCR) by adding temperature controlling procedure in the future. [C2581]

"Avery Dennison micro-nano replication capabilities for MEMS and microfluidics"

Polymers can be used as one of most promising materials for MEMS applications. In this paper, we successfully demonstrated embossing micro-nano structures on polymers, especially high temperature polymers (>300°C) by using Avery's unique proprietary embossing technology. Also in this paper, we demonstrated a roll-to-roll embossing/lamination method for manufacturing low cost plastic microfluidics devices. [C2582]

"Injecting and controlling spin populations and currents in semiconductors using optically induced quantum interference effects"

Summary form only given. This paper reviews the recent developments of epitaxial ferromagnetic heterostructures based on semiconductors for spintronics. The magnetotransport of prepared ferromagnetic III-V semiconductor heterostructures (Mn-delta-doped GaAs/Be-doped AlGaAs) and the control of ferromagnetism in the heterostructures by using gate electric field and light irradiation at relatively high Curie temperature (TC) (100 K) are also studied. This paper proposes and theoretically analyzes a spin MOSFET consisting of a MOS gate and ferromagnetic contacts for the source and drain. The spin MOSFET has large magnetocurrent ratios (spin dependent transport similar to the GMR or TMR devices), high transconductance (gm), and good

compatibility with CMOS technology, which are very important for integrated circuit applications. [C2583]

"Development of a non-continuous micro-flow opto-wetting droplet manipulation technology"

The aim of this research is to develop a light actuated droplet manipulation system. This research utilized ultraviolet to activate oxidation-reduction mechanism of nano-TiO₂ photocatalyst coating on the base material. The water-affinity of the base material changed due to the decrease in free-energy of the material surface. The contact angle between the liquid droplet and base material also changed to facilitate the manipulation purpose. In this study, the system that was developed includes which ultraviolet masking device, moving platform, main frame structure etc. The software was developed by using Microsoft Visual Basic 6.0. Upon completion of hardware and software integration, experiments were carried out to verify system functionalities. This study developed a non-continuous opto-wetting droplet manipulation technique. By exposure to 6.8 mW UV light, the surface tension of coating nano-TiO₂ (Anatase type, 3.5%, PH 1.5, and with average diameter of 69 nm) changed for the sake of changing hydrophilic. The change in surface tension is applied to drag the droplet. The moving rate of dragging was 3.33 mm/sec. This technique overcomes the shortcoming of opto-electrowetting technique. The programming function of this technique can also be applied to the clinic test in the future. [C2584]

"Preface"

{no data available} [C2585]

"Novel one dimensional nanostructures"

Summary form only given, as follows: the combination of remarkable mechanical properties and unique electronic properties of carbon nanotubes (CNTs) offers significant potential for revolutionary applications in electronics devices, computing and data storage technology, chemical and biosensors, composites, nanoelectromechanical systems (NEMS), and as tip in scanning probe microscopy (SPM) for imaging and nanolithography, most of which are the subject areas of ICMENS2005. The ability to grow inorganic nanowires with controlled properties and orientation provides another competitive avenue for some of the applications mentioned above particularly in sensors and electronics. In this talk growth and characterization of both CNTs and inorganic nanowires such as germanium and high temperature oxides will be discussed with a focus on the applications. [C2586]

"CONAN-a design exploration framework for reliable nano-electronics architectures"

In this paper we introduce a design methodology that allows the system/circuit designer to build reliable systems out of unreliable nano-scale components. The central point of our approach is a generic (parametrical) architectural template. Configurable nanostructures for reliable nano electronics (CONAN), which embeds support for reliability at various levels of abstractions. Some of the main reliability sources are regular and decentralized structures based on simple basic computation cells designed to be robust against disturbances and noise, fault tolerance based on hardware, time and information redundancy applied at the basic cell level as well as at higher levels, self diagnosis assisted by the dynamic reconfiguration of basic computation cells and interconnect rerouting. Within the CONAN template, both technology dependent and independent models co-exists such that the more abstract layers are technology independent while the lower levels can be retargeted to various fabrication technologies. Our proposal is application-oriented and allows the designers to deal with unpredictability, and low reliability, which are unavoidable characteristics of future emerging nano-devices. When combined with the underlying software, the tools supporting the CONAN approach allow the designer to check whether the design constraints are fulfilled before performing a detailed implementation and provides means to trade area, delay, and power consumptions for reliability. As such, this proposal is a call-to-arms to mobilize the efforts of systems designers in order to achieve a systematic design methodology for reliable systems. [C2587]

"Proceedings. 2005 International Conference on MEMS, NANO and Smart Systems"

{no data available} [C2588]

"A parametric study of thermal effects on the reliability of RF MEMS switches"

The influence of thermal effects on the reliability of RF MEMS switches is investigated in this paper. Low power consumption and capacity to handle high power at very high frequency elevate the scope of RF MEMS in the field of satellite and mobile communication technology immensely. The reliability of these switches are still under consideration as they fail due to thermal stresses developed during operation. A significant temperature rise occurs while transmitting high power at high frequency. In this paper, we introduced design parameters and investigated their influence to improve the switch's resistance to acute thermal stresses. A three dimensional finite element model of RF MEMS switch was simulated. A current density model and a thermal model were

coupled to calculate the current density, heat loss and temperature rise within the domain. The maximum frequency and power range that the switch can handle before buckling failure were estimated. [C2589]

"Thermal design of an HTP microthruster"

A microscale thruster, has been successfully designed using MEMS technology, in that 'stacked wafer' design is adopted. The thruster is built up of stacked and bonded silicon wafer, each with its own internal structure. The MEMS technology has succeeded in achieving good performance and relatively short heat-up transient. This paper describes the preliminary design and detailed thermal analysis. The microthruster is designed to be used on small satellites, to deliver small impulse bits micro/nano-satellites for δV impulses. [C2590]

"The smallsat TIR spectrometer MIBS (macro system enabled by micro system technology)"

In frame of the ESA Earthcare MSI study, TNO Science and Industry has developed a compact spectrometer which is optimized for operation in the 7 to 14 μm wavelength region. By optimizing the throughput of the system, and using the advantages of modern manufacturing technologies to the largest extent possible, an instrument has been created that can be flown on a multitude of missions. Extensions to other wavelength regions can be accommodated due to the all reflective fore optics system. [C2591]

"RF MEMS for space applications"

The mass, volume and dc power consumption of payload electronic equipment is a significant contributor to the overall cost of space systems. The radiofrequency (RF) microelectromechanical system (MEMS) technology offers the potential of large reduction in mass and volume of electronic equipment, by replacing the waveguide and coaxial switch matrices with their MEMS counterparts. Mass reductions can be also exploited to increase the satellite system capacity (by adding payload electronics) or to extend operational life (by increasing station keeping fuel). As a result, market factors have constantly been pushing hardware suppliers to reduce mass and size of their space-based products. [C2592]

"A high-voltage integrated circuit engine for a dielectrophoresis-based programmable micro-fluidic processor"

A high-voltage (HV) integrated circuit has been demonstrated to transport droplets on programmable paths across its coated surface. This chip is the engine for a dielectrophoresis (DEP)-based micro-fluidic lab-on-a-chip system. This chip creates DEP forces that move and help inject droplets. Electrode excitation voltage and frequency are variable. With the electrodes driven with a 100V peak-to-peak periodic waveform, the maximum high-voltage electrode waveform frequency is about 200Hz. Data communication rate is variable up to 250kHz. This demonstration chip has a 32432 array of nominally 100V electrode drivers. It is fabricated in a 130V SOI CMOS fabrication technology, dissipates a maximum of 1.87W, and is about 10.4 mm \times 8.2 mm. [C2593]

"Development of miniature visual monitoring cameras at OIP"

This paper describes small modular cameras for space applications, which have been developed by OIP Sensor Systems. These cameras are based on CMOS Active Pixel Sensors (APS) developed by FillFactory. The "Visual Monitoring Cameras" (VMC) are mostly developed under ESA contracts and are used for observing the deployment of mechanisms such as solar panels and antennas on board satellites. The VMC cameras are also suitable for monitoring the separation phases of satellites and landers from their spacecraft, by means of a sequence of snap shot images. Numerous VMC cameras have been successfully launched on the XMM satellite, CLUSTER II, PROBA, ARIANE V and the MARS-EXPRESS mission. In this paper the design of the VMC cameras, that have been developed, are described, and possible future developments are discussed. [C2594]

"Impact of nanotechnology in flat panel display industry"

Summary form only given. Flat panel display industry is a highly competitive area, globally driven by the intricate balance between technical advancement toward better performance and the ever demanding production cost. Along the vertically integrated manufacturing of FPD's, there always exists a technology-cost bottle neck that defines and often limits the growth of the market. Nanotechnology, as a collective field of precision materials science and engineering, provides rich opportunities in innovations in all aspects of FPDs: Carbon nanotubes for efficient field emission display, patterned surface-alignment for memory LCDs, nanostructure-reinforced glass substrate, nanophase-separated polymer films for self-assembled antireflection coating, nano-metallic particles for conductive ink semiconductor quantum dots for color filters and fluorescent screens nano-imprinting, scanned probe fabrication, high-resolution inkjet printing, and many more. In the face of FPD development in the past few decades, these emerging technologies appear qualitatively new and sometimes even disruptive in the sense that,

if properly integrated, they will profoundly revolutionize the basis of the industry. In this paper, the author would like to outline my personal perspective about how this will happen and change the industry to become compatible with the increasing environmental pressure without sacrificing the display performance. [C2595]

"Polysilicon fatigue test-bed monitoring based on the 2nd harmonic of the device current measurement"

As the micro technology field expands, the need of simple and standardized methodologies enabling to precisely evaluate device functionality and reliability increases. In particular, under operating conditions, polysilicon devices, e.g. accelerometers, gyroscopes and torsional micromirrors, are stressed by cyclic mechanical loading. Consequently, the characterization of long-term durability of polysilicon components becomes of primary importance to guarantee MEMS reliable functioning during the whole life. In this paper, the experimental set-up of a polysilicon fatigue test bed based on the 2ndharmonic of the device current is proposed. The method focuses on the fact that the electrical output signal of electrostatically actuated microdevices is proportional to the driving velocity; thus an indirect system displacement monitoring is achievable and the sample breaking can be registered by electrical measurements. The technique takes advantage of on-chip test design combined with electrostatic actuation and provides with the development of inexpensive and stable test-systems. [C2596]

"Aerosol drug delivery to the lung periphery using nanoscale technologies"

Two applications of nanotechnology to the AERx® drug delivery system are presented. Improved delivery performance is demonstrated using nanoscale nozzles. This gives higher emitted doses with reduced aerosol particle sizes, leading to deeper penetration of the drug into the lung periphery. Expanded capabilities are demonstrated using n a nanosuspensions. For example, drugs that are otherwise poorly soluble can be delivered to the lung periphery using nanosuspensions. [C2597]

"Numerically modeled dynamic response of perfect and leaky dielectric droplets in an electric field"

Summary form only given. A dielectric liquid droplet in an immiscible dielectric medium will deform when subjected to an external electric field. This effect is a component of the motion seen in electrically actuated droplets in a lab-on-a-chip setting, and is being studied in order to provide a basis for modeling electrowetting actuation behaviour. It is, however, a widely studied phenomenon in its own right, and can be employed in various emulsion technologies. The present work is a finite element analysis of both the perfect and leaky dielectric models, taking into account the time dependence of the deformation and the nonlinearity encountered when the deformation becomes large. In order to assess the accuracy of the model, comparisons are made with the classical small-deformation analytic results and with recent finite element results. The effects of the fluid properties and the applied field on the transient response and the resulting deformation are observed, and the transient response in particular is analyzed in order to provide a basis for dynamic control of the system. This could lead to a strategy for reliably controlling the behaviour of droplets under electrowetting actuation on a microfluidic chip. [C2598]

"Digital communication systems: the problem of analog interface circuits"

Due to the use of deep sub-micron and nano technologies, the signal processing in the digital area becomes so powerful that the limitations are again situated in the analog front-end circuits. This becomes a huge problem in signal output drivers. The development of xDSL and RF systems all lack efficient power amplifiers, especially if they have to be realized in standard CMOS technologies. Another challenge is the design of wide-band receiver front-ends including low-noise input-matched CMOS amplifiers. An overview of the limitations, trends and some recent achievements from the open literature were analyzed and discussed. [C2599]

"Next generation fiber optic sensing and its applications"

Summary form only given. In the past, fiber optic sensing has made profound impact to several fields including civil, mechanical and biomedical engineering. Today, there is an increasing demand for sensors that includes homeland-security, military, industrial and infrastructure where fiber optic sensor is able to continue to play as a key enabler to meet the needs. More than usual, these fiber sensors faces harsh operating conditions with high temperatures, corrosion/erosion surroundings, high-vibration, voltage and pressure environment. The future requirements includes long operating-life, high accuracy, low field maintenance and low cost. In this talk, I introduce a new fiber optic sensor that is able to operate in the harsh environment (for example, 1000C) with extended life based on a novel permanent fiber grating technique. We also develop a nano-membrane technology on the surface of the fiber where it functions as the interaction agent with the surrounding chemical and gases. Unlike the traditional catalysis, this membrane sustains high-temperature and is re-conditionable in the field. These technologies open up opportunities to use fiber-grating sensors in power generation system

(gas/steam turbine, coal-fire boilers, and aircraft engines); in oil and gas applications (down-hole sensing, sub sea station and reservoir monitoring); and in the area of biochemical detection. [C2600]

"Redefine optical devices' integration and manufacturing through nano-engineering"

Summary form only given. Optical industries are 30-year behind semiconductor industry. Conventional optical devices such as polarizers, waveplates, beam-splitters, reflectors, filters and lenses, are all manufactured through different scattered and incompatible design and manufacturing platforms, which make the integration and miniaturization impossible. With recent advance of nanotechnology, it becomes possible to manufacture optical nano-structures with high precision, high throughput/volume, and low cost. Based on this, we could redefine each fundamental optical device function and associated manufacturing method through nano-engineering. This leads to a new path for optical integration. A nano-manufacturing platform based on wafer level nano-replication with mold and nano-pattern transfer by nano-lithography is reported here. The nano-replication process, which based on imprinting a single-layer spin-coated UV curable resist, achieved excellent nano-patterning fidelity and on-wafer uniformity with high-throughput. Nano-optic devices, such as quarter wave plates and polarizers, were manufactured with the nano-manufacturing platform. Excellent wafer level performance and yield were achieved. The developed technology is suitable for high-throughput and low cost manufacturing needs for commercializing nano-structure based optical devices and integrated optical devices. In the past three years, we have processed more than 1000 4"-in-dia wafers for nano-optic polarizers and waveplates by using the described nano-manufacturing technology. Statistically, we have achieved nano-replication wafer throughput of 20 wafers/hour. For both nano-optic polarizer and waveplate wafers, we have achieved average on-wafer optical yield of 80%, and the fabrication cost was estimated to be about \$0.01/mm² with a 4" in-dia wafer processing line. The fabrication cost is at least 2 to 10 times lower than existing technologies for making similar polarizers (e.g., Polarcor™ or CuPo™) and waveplates (e.g., quartz waveplates or polymer sandwiched waveplates). Various integrated nano-optical devices were also fabricated and discussed. [C2601]

"Thin film magnetic materials for RFIC passives"

Recent developments of magnetic thin films for monolithic integrated radio frequency (RF) passive components are reviewed. Challenges of applying magnetic films for RF devices, i.e. ferromagnetic resonance (FMR) and eddy current effects are discussed. Nano-granular magnetic materials are foreseen to be one of the most suitable candidate materials for RFIC for the low eddy current losses and the high FMR. Magnetic RF components, such as current controlled tunable inductors, shortened $\lambda/4$ transmission line, band-stop and band-pass filters, harmonic noise suppressors are discussed. A novel metal/ferromagnetic (FM) multi-layer structure is proposed to reduce eddy current loss. Prospects of integration of magnetostatic wave based components are discussed. [C2602]

"Effectiveness of low power dual-V_t designs in nano-scale technologies under process parameter variations"

This paper explores the effectiveness of dual-V_t design under aggressive scaling of technology, which results in significant increase in all components of leakage (subthreshold, gate and junction tunneling) while having large variations in process parameters. The present way of realizing high-V_t devices results in high junction tunneling leakage compared to low-V_t devices, which in turn may result in negligible leakage savings for dual-V_t designs in scaled technologies. Moreover, increase in process variation severely affects the yield of such designs. This paper suggests important measures that need to be incorporated in conventional dual-V_t design to achieve total leakage power improvement while ensuring yield. It also shows that different process options, such as metal gate work function engineering, are required to realize high-performance and low-leakage dual-V_t designs in sub-50nm technologies. [C2603]

"1D nano-ultrasonic scan with 1-nanometer spatial resolution"

Piezoelectric quantum wells can be treated as opto-acoustic transducers to generate and detect acoustic waves with nanometer wavelengths. This opto-acoustic transducer was utilized for 1D ultrasonic scan with 1 nanometer demonstrated resolution. [C2604]

"Diamond and carbon nanorubes and their applications to MEMS and NEMS"

Outstanding mechanical, thermal, optical, chemical, electrical, and biocompatible properties of diamond and carbon nanotubes, and their implication to and current status of practical applications to micro- and nano-electromechanical systems (MEMS/NEMS) are discussed. State-of-the-art manufacturing technologies for these materials and related processes for fabrication of high performance MEMS and NEMS are presented. [C2605]

"DC and AC characteristics and modeling of Si SSD-nano devices"

Silicon nano scale self switching device (SSD) and side gated transistor (SGT) are nano scale active components. These devices are manufactured with silicon-on-insulator (SOI) technology and are operative at room temperature. Simple transistor level models are developed for them. The model parameters are extracted from test structures. The SSD model was verified with test sample measurements. The model show good DC correspondence with the measured values. AC model gives fT results that are slightly optimistic but of the right order of magnitude. [C2606]

"Efficacy of the Thermalized Effective Potential Approach for Modeling Nano-Devices"

The efficacy of the thermalized parameter-free effective potential approach described elsewhere is examined with regard to its application to modeling of alternative device technologies. Our investigations suggest that the Hartree correction is significant only for very high doping densities, as it is the case in deca-nano MOSFETs. For low doping densities, as it is usually the case in alternative device structures, such as dual-gate and FinFET devices, the Hartree term can be neglected and the Barrier term needs to be included in the model only. Since the Barrier field is pre-calculated in the initialization stages of device simulation, it does not add any additional computational cost, thus leading to a very effective way of including quantum mechanical space-quantization effects in the computational model. [C2607]

"Fabrication of self-aligned drain and source on insulator MOSFET with dielectric pocket by local SIMOX technology"

In this work, a method to fabricate SA-DSOI MOSFET with dielectric pocket has been presented. Dielectric pocket and BOX are realized by local SIMOX technology. This novel structure results in good SCE and SHE suppression and higher speed performance, which is very important in nanoscale device design. With this novel self-aligned process, DSOI MOSFET can be scaled down to nano-scale and becomes a promising device. [C2608]

"Nano-silver paste with low roasting temperature"

A kind of new silver paste with silver content about 50wt%, nano-silver paste, significantly different with normal silver paste in roasting temperature, was prepared using nano-silver powder, ethanol, n-butyl alcohol, n-hexyl alcohol and low polymer fibre. The nano-silver paste shows weight loss and volatilization with different levels on thermogravimetric (TG) analyzing curve. Field emission scanning electron microscope (FESEM) analysis indicates when roasting temperature is controlled at 200°C, the surface of finished silver film has already been compact and smooth. And finished silver film has stronger adhesive with ceramic and metal substrates, while the adhesive is poor with slippery glass. The minimal square resistor of obtained silver film can reach $7.8\text{m}\Omega/\text{cm}^2$. [C2609]

"An experimental study about the surface behaviour, under electrical stress in contaminated wet conditions, of different nanostructured polymers"

A joint research project University of Genova/Politecnico di Torino regards the influence of selected fillers, inserted to obtain different micro and nano-structured compounds of ethylen vinyl acetate (EVA) copolymer, on the surface electrical behaviour, in presence of artificial wet contamination (macroscopic tracking). Three polymer composites have been realised, of which two contained fluorohectorite as nanofiller. Fluorohectorite is a layered silicate (clay); when its molecules are organically modified, polymeric macromolecules can set between their layers, enabling the formation of nanoscale range geometries along one dimension, thus increasing dramatically the interface interactions. A mix of fluorohectorite (nanofiller) and trihydrate alumina (THA microfiller) is also considered. Suitable tests were carried out on flat specimens in order to rank the performances of the above materials. The electrical tracking tests outcome indicates different results in the case of EVA with THA and fluorohectorite presenting a better behaviour with respect to the other considered materials. [C2610]

"Design of a development platform for HW/SW codesign of wireless integrated sensor nodes"

Wireless integrated sensor networks are a new class of embedded computer systems which have been made possible mainly by the recent advances in the micro and the nano technology. In order to efficiently utilize the limited resources available on a sensor node, we need to optimize its key design parameters which is only possible by making system-level design decisions about its hardware and software (operating system and applications) architecture. In this paper, we present the design of a sensor node development platform in relation to an application of wireless integrated sensor networks for sow monitoring. We also discuss the related

hardware/software codesign tradeoffs. [C2611]

"A mapping algorithm for defect-tolerance of reconfigurable nano-architectures"

Self-assembled nano-fabrication processes yield regular and reconfigurable devices. However, defect densities in this emerging nanotechnology are higher than those in conventional lithography-based VLSI. In this paper, we present a defect-tolerant design flow to minimize customized post-fabrication design efforts to be performed per chip. We also present a greedy $O(n \log n)$ mapping algorithm which makes the connection between defect-unaware design steps and the final defect-aware step. Experiments show that the results obtained by this algorithm are very close to the exact solutions. [C2612]

"Projection-based performance modeling for inter/intra-die variations"

Large-scale process fluctuations in nano-scale IC technologies suggest applying high-order (e.g., quadratic) response surface models to capture the circuit performance variations. Fitting such models requires significantly more simulation samples and solving much larger linear equations. In this paper, we propose a novel projection-based extraction approach, PROBE, to efficiently create quadratic response surface models and capture both inter-die and intra-die variations with affordable computation cost. PROBE applies a novel projection scheme to reduce the response surface modeling cost (i.e., both the required number of samples and the linear equation size) and make the modeling problem tractable even for large problem sizes. In addition, a new implicit power iteration algorithm is developed to find the optimal projection space and solve for the unknown model coefficients. Several circuit examples from both digital and analog circuit modeling applications demonstrate that PROBE can generate accurate response surface models while achieving up to 124 speedup compared with the traditional methods. [C2613]

"Progress in R&D on wearable and implantable biomedical sensors for better healthcare and medicine"

The management and coordination of healthcare and medicine throughout the entire range of services, from primary to tertiary care, undergo fundamental changes such as, more emphasis on prevention and education of users, new ways of delivering care and empowerment of individuals to manage their own health. This is being possible mainly thanks to extraordinary progress in sciences and technologies e.g. micro and nano technologies, mobile communications, human computer interface and genomics. Integrated smart micro and nano systems provide large spectrum of solutions spanning from health monitoring and diagnosis at the point of care, to chronic diseases management, healthy lifestyle support and human performance monitoring and assessment. Communicative biomedical sensors/biosensors and wearable integrated systems are becoming major driving forces for cutting edge developments. Further research in the intersection of disciplines like micro-nano technologies, materials, physiology/biology/medicine and Information & Communication Technologies (ICT) is necessary in order to achieve highly performing, user-friendly, and cost-effective wearable and implantable medical/healthcare systems. [C2614]

"Nanomaterials for optoelectronic devices"

Through molecular design and synthesis, we have synthesized many nanoparticles and fabricated into optoelectronic devices. Au-C60 arrays were deposited on the top of pairs of gold electron to single electron transistors. Silica nanoparticles were used to create nano-structure on silicon and fabricated into infrared light emitting diode (LED). CdS and CdSe nanoparticles have been fabricated into visible light LEDs. CdSe nanoparticles can be infiltrated into self-assembled photonic crystal to modulate light emission and light reflection. CdS nanoparticles were hybrid with MEH-PPV to fabricate photovoltaic devices. [C2615]

"Microchip electrophoresis and related technologies"

Microchip electrophoresis is emerging as a highly promising method for fast analysis with minimum amount of analytes. While this platform has been well recognized, there are many technical challenges remained to be solved in order to broaden its usefulness. In the first part of this presentation, we demonstrate on-chip assays for fast analysis of estrogen related binding cascade to monitor both ligand binding and estrogen responsive element (ERE) binding, which serve as screening assays for steroid-like compounds. The method requires only nanograms of samples and the run time is within minutes. In the second part of this presentation, the author demonstrates a novel surface modification for a common substrate of microchip electrophoresis, polydimethylsiloxane (PDMS). We have created a permanently hydrophilic PDMS surfaces using electrostatic self-assembly and chemical cross-linking. Electrokinetic analysis of the coatings in microchannels always exposed to air gave constant electroosmotic flow during the six months that the measurements were done. [C2616]

"Defects, yield, and design in sublithographic nano-electronics"

It is anticipated that defect densities in bottom-up self-assembled nanotechnology are much higher than those in conventional VLSI technologies. Therefore, defect tolerance needs to be included in various steps of the design automation flow. In this paper, a new defect tolerant flow is proposed and a new yield metric, based on this flow, is defined. This metric is evaluated for various molecular crossbars with different defect densities. Test and diagnosis of molecular crossbars, as the main building blocks in this technology, are also investigated. [C2617]

"2005 IEEE LEOS Annual Meeting"

The following topics are dealt with: careers in optical engineering optoelectronics research; lasers in remote sensing; quantum dots; quantum optics; laser materials; laser sources; integrated optics; optical signal processing; nano-optics; nonlinear optics; novel biophotonic systems; terahertz imaging applications; quantum nanostructures; optical fiber communication; terahertz sources; photonic nanostructures and applications; optical interconnects; nanophotonic light emitters; optical fiber; avalanche photodiodes; holographic systems; transmission and modulation formats; microwave modulation techniques; optoelectronic packaging performance and reliability; liquid crystal displays; plasmonic and resonant nanostructures; optical materials; radio-over-fiber systems and components; organic light emitting diode displays; SOI and nonlinear devices; quantum communications; waveguide devices; optical fabrication; manufacturing strategies for optoelectronic packaging; flexible displays; low noise microwave generation; systems and sensor technologies; ultrafast semiconductor devices; and microwave signal processing [C2618]

"Towards a molecule-computer? Resources and technologies to compute within a single molecule"

The seminal Aviram-Ratner paper in 1974 had triggered the interest on a future molecular computer technology. In this direction, the first step is to realize a digital logic function with a molecule (Joachim et al., 2000). This requires (1) specific design rules depending on the semiclassical or quantum version of the logic function, (2) specific molecules with an internal board ensuring the function, (3) the board must be equipped with different chemical groups to ensure the portability of the function and its interconnection to users, (4) an atomic scale technology to secure user-molecule data & synchro signals exchange, the so-called nanocommunication problem. Finally, (5) production may not be solid state like as compared with micro (and nano)-electronic because of environmental concerns (Khuer and Williams, 2003). We review all those steps providing the state of the art in each case. [C2619]

"Silicon nano-photonics: where the photons meet the electrons"

It has become apparent that silicon technology can provide many of the requirements for nanophotonic integration, including many of the common discrete optoelectronic components. Some of these components are based on photonic crystal designs, but generally electromagnetic design becomes the main research requirement in nanophotonics. The question has always been what is the exact structure that should be fabricated. The era of purely intuitive design may be obsolete. We must now concentrate more on design software, rational design, and the numerical solution of inverse problems. There are a number of inverse algorithms, including genetic algorithms, the error-propagation method, and simulated annealing that can contribute to future progress in nanophotonic design. [C2620]

"Nano-technology in silicon foundries"

Foundry has been quietly manufacturing VLSI products based on today's nano-scale transistors. Further scaling is becoming more and more challenging. There are lots of opportunities to collaborate between academia and Foundry to push the frontier nano-science research, so that more options become available to future scaling. New, none-IC materials and structures are being exploited for the continuation of scaling and new functions. Among these, a successful marriage of Si electronic devices and spintronics can bring in a new kind of memory device previously not available. It has been about 30 years of exciting evolution. It is expected that the next 30 years will be more exciting. [C2621]

"Development of nanotechnology for biomedical applications"

This paper discusses the technological advancement in nanotechnology and some aspects of applications in engineering devices and biotechnologies. The lecture outlines the logical development of technology and engineering following (1) initiation of idea and visualization, (2) ability to control and measurements and (3) intense effort in engineering developments. The paper includes a brief review of the historical development in biology, nano and potential applications of electro-magnetic phenomena. The paper also describes the activities

in the Center for Nanomagnetism and Biotechnology for clinical applications using nanomagnetic particles. Several magnetic phenomena in life sciences are illustrated. Brief discussions of nano materials are introduced. The paper then concludes with possible near term applications and long term developments of nanotechnology in biomedical and bioengineering. [C2622]

"DOA estimation of ultra wide band impulse radio signal"

For ultra wide band impulse signal direction of arrival estimation, conventional wide band algorithms need to divide the wide band frequency into narrow band bins, but the time width of an impulse is about a nano second and the collected signal duration to do Fourier transform is about a few nano seconds, does the frequency resolution satisfy the narrow band condition? We show that the narrow band assumption also hold. We also obtain the signal noise ratio loss when only one frequency bin data is used to do DOA estimation. When impulse waveform is known, a subspace-based high resolution joint DOA delay estimation algorithm is obtained. [C2623]

"The integration of bio, micro and nano technologies to produce a range of medical implants from the Healthy Aims project"

This paper describes how new medical implants are being developed under the Healthy Aims Project, integrating a range of technologies. [C2624]

"Nano resolution imaging technique with a near-field scanning microwave microscope"

We demonstrated a near-field scanning microwave microscope (NSMM) with a nano spatial resolution using a hybrid tip. In order to understand the function of the probe, we fabricated the hybrid tip with a flat shaped shoulder and a reduced length of the tapered part using a conventional chemical etching technique. Two different NSMM images were observed for patterned Cr films on glass substrates and analyzed as a function of the apex and the cone angle of the tapered part. The hybrid tips were coupled to a high quality dielectric resonator at an operating frequency $f = 4.46$ GHz. By using the hybrid tip, we demonstrated an improved high contrast NSMM image of lambda phase DNA on a glass substrate. [C2625]

"Characterization of nano-size YVO₄:Eu and (Y,Gd)VO₄:Eu phosphor via low voltage cathodoluminescence"

Low voltage cathodoluminescence (LVCL) measurements were carried out to better understand the role of Gd in (Y,Gd)VO₄:Eu phosphor and to compare solid-state reaction (SSR) with coprecipitation method (PM) to synthesize those phosphors. From the analysis of LVCL measurement, it is believed that there is no interaction between Gd and Eu, and Gd affects only the symmetry of Eu site. It is also found that nano-size YVO₄:Eu phosphor synthesized by PM shows low quantum yield in comparison with that synthesized by SSR. [C2626]

"Integration of photonic functions in and with silicon"

Silicon is gaining importance in photonic systems on a chip, either because of the importance of integrating photonic functions with electronic functions or because of the potential of silicon-based technology for photonics as such. In this paper, we discuss two distinct developments. The first is the development of nano-photonic integrated circuits based on photonic crystals or photonic wires. The second is the development of heterogeneously integrated active photonic components on top of silicon by means of wafer bonding. [C2627]

"Observation of electron emission pattern from nano-split emitter fabricated using beam assisted process"

The possibility of interference of electrons from a nano-split emitter fabricated using beam assisted processes has been investigated. With the gap size of 16 nm, the emission pattern with two spots was observed at a gate voltage close to the turn-on voltage. At the higher gate voltages, two spots become overlapped but no interference fringes were observed at room temperature. [C2628]

"Estimation of delay variations due to random-dopant fluctuations in nano-scaled CMOS circuits"

In nano-scaled CMOS circuits, the random dopant fluctuations cause significant threshold voltage (V_t) variations in transistors. In this paper, we propose a semi-analytical estimation methodology to predict the delay distribution (mean and standard deviation) of logic circuits considering V_t variation in transistors. The proposed method is fast and can be used to predict delay distribution in nano-scaled CMOS technologies both at the circuit and the device design phase. [C2629]

"High resolution two-dimensional carrier profiling on sub-100nm silicon nano-devices using scanning spreading resistance microscopy"

This work presents the recent progress in scanning spreading resistance microscopy(SSRM) capabilities highlighting enhanced spatial resolution ([C2630]

"Study on RTV silicone rubber/SiO₂ electrical insulation nanocomposites"

Surface contamination and leakage current have caused operating problems for utilities since electric power was its infancy. A flashover in a substation may result in the destruction of an insulator or many others electrical equipments. In order to reduce the incidence of insulator flashover and damage, the liquid silicone RTV (room temperature vulcanized) has been used for coating porcelain and glass insulators to provide water repellency (hydrophobicity) on the surface. Nano science and technology (nano-st) is a promising research field. In this paper, from previous research results in the other research fields, we decide to select nanoSiO₂ to try to reform RTVSR. First, different kinds of nano SiO₂ from different fabrication methods such as sol-gel and gas phase method etc are selected. Then dispersal situation of nano SiO₂ synthesized by different ways and disposed with or without coupling agents in RTV silicone rubber were studied and analyzed with SEM. Some basic properties of RTVSR/SiO₂ nanocomposites and pure RTVSR were compared and analyzed in detail. In addition, some electrical performances tests are also conducted, and the influences to the electrical parameters such as $\tan \delta$, and p_w were found as well, considering that RTV silicone rubber was a kind of electrical insulation materials. The resulting hybrid had more excellent mechanical, thermal stability than pure RTV silicone rubber. [C2631]

"Direct deposition of Cu/barrier stacks on dielectric/nonconductive layers using supercritical CO₂"

Metallization in supercritical CO₂(scCO₂) is a method to form nano-interconnects for future generation LSIs. It has been recognized that metal layers, Cu for instance, grow only on conductive layers thus requires an underlayer or 'activation' treatment to promote nucleation. Such a layer is formed by a conventional way, which may limit the potential of scCO₂ deposition. The keys to solve this issues are: 1) to develop a way to deposit a conductive barrier layer, and 2) to develop a proper chemistry to deposit the barrier layer directly on dielectric/nonconductive layers from scCO₂. The focus of this work is to form Cu/barrier stacks on dielectric layers using only scCO₂. [C2632]

"Nonvolatile memory technology: a view of the future"

Summary form only given. Intel's ETOX flash memory technology has followed Moore's Law for nine generations and with the introduction of 90 nm technology, moves into the nanotechnology age. Scaling is expected to continue but with increasingly difficulty. A number of new technologies are proposed as future candidates, including many based on new nano technology concepts reported recently. With memory cost as the value set, the attributes leading to low cost memory are discussed and be used to compare the different new nanomemories. Multi-level, multi-layer and seek and scan memories have the potential to be the lowest cost. [C2633]

"Aluminum nano interconnects"

The physical and technological limitations for aluminium interconnect technology in the deep sub-100 nm regime are investigated. Using a wet chemical process for hard mask trimming the fabrication of nano Al interconnects has been demonstrated. Based on first electrical measurements the electrical size effect of Al interconnects with critical dimensions far below 100 nm as well as the impact of side wall roughness are discussed. [C2634]

"A nonvolatile nanoelectromechanical memory element utilizing a fabric of carbon nanotubes"

Manufacturability of electronic devices based on carbon nanotubes (CNT) generally depends on the ability to manipulate and control individual structures at the molecular level. A novel technique has been developed to overcome this hurdle, allowing CNT-based nano-electromechanical devices to be fabricated directly on existing production CMOS fabrication lines. The first demonstration of this technique has resulted in a CNT nonvolatile memory element. This unique approach relies on the deposition and lithographic patterning of a 1-2 nm thick fabric of nanotubes which retain their molecular-scale electromechanical characteristics, even when patterned with 180 nm feature sizes. Individual patches of this CNT fabric can be elastically deformed by electro-static attraction to metal electrodes, creating a pair of stable nonvolatile states around the equilibrium of two molecular-level forces: an attractive van der Waals force and the restoring tensile strain within the deformed fabric. A CMOS-compatible fabrication process for these devices has been developed and demonstrated which is free from metallic or material contaminants and particulates. Because these nonvolatile memory elements are created in an all thin-film process, they can be monolithically integrated directly within existing CMOS circuitry to facilitate

addressing and readout. Design considerations and preliminary device switching characteristics are presented. [C2635]

"Development of an automated microinjection system for fabrication of carbon nanotube sensors"

A novel automated carbon nanotube (CNT) microinjection system for batch fabricated bulk multiwalled carbon nanotubes (MWNT) based MEMS sensor is presented. The basic process includes AC electrophoretic manipulation of MWNT bundles on a silicon substrate and embedding them inside parylene C layers to provide a robust protection for the bundled MWNT. By utilizing AC electrophoretic technology, CNTs were successfully and repeatedly manipulated between micro-fabricated electrodes. Besides, the devices were demonstrated to potentially serve as novel thermal sensors with low power consumption (μW) and fast frequency response (100 kHz). Based on these experimental evidences, a feasible batch manufacturable method for functional CNT sensors by using the automated injection system is developed which will dramatically reduce production costs and production time of nanosensing devices and potentially enable fully automated assembly of CNT based devices. [C2636]

"Development of highly robust nano-mixed Hfx Aly Oz dielectrics for TiN/Hfx Aly Oz /TiN capacitor applicable to 65nm generation DRAMs"

TiN capacitor with Nano-mixed HfxAlyOz dielectric was successfully demonstrated to be applicable to 65nm DRAM devices. Nano-mixed HfxAlyOz thin film by ALD (Atomic Layer Deposition) showed an excellent thermal stability even up to 700°C without any leakage current degradation. Moreover, Nano-mixed films revealed lower leakage current than laminate due to effective nano-scale mixing of HfO₂ and Al₂O₃. TiN/HfxAlyOz/TiN capacitor turned out to be applicable to 65nm DRAM showing low EOT of 11E and low leakage of 1 fA/cell. [C2637]

"Tools and techniques for evaluating reliability of defect-tolerant nano architectures"

Nano-computing in the form of quantum, molecular and other computing models is proliferating as we scale down to nano-meter fabrication technologies. However, it is expected that nano-scale devices and interconnections will introduce unprecedented level of defects in the substrates and architectural designs need to accommodate the uncertainty inherent at such scales. This consideration motivates the search for new architectural paradigms based on redundancy based defect-tolerant designs. However, redundancy is not always a solution to the reliability problem, and often too much or too little redundancy may cause lack of reliability. The key challenge is in determining the granularity at which defect tolerance is designed, and the level of redundancy to achieve optimal reliability. Also, redundancy has been applied at different levels of granularity, such as gate level, logic block level, logic function level, unit level etc. Analytical probabilistic models to evaluate these levels are error prone and cumbersome, and do not scale well for complex network of gates. We develop different tools and techniques that can evaluate the reliability measures of combinational logic blocks, and can be used to analyze trade-offs between reliability and redundancy for different architectural configurations. In particular, we report two tools, one of which is a Matlab based tool called Nanolab and the other is a probabilistic model checking based tool named Nanoprism. We also illustrate the effectiveness of our reliability analysis tools by pointing out certain anomalies which are counter-intuitive but can be easily discovered by these tools, thereby providing better insight into defect-tolerant design decisions. We foresee that these tools will help furthering research and pedagogical interests in this area, expedite the reliability analysis process and enhance the accuracy of establishing reliability-redundancy trade-off points. [C2638]

"Cu/ULK integration using a post integration porogen removal approach"

This paper is focused on a new integration scheme to perform Cu/porous ULK interconnects. The dielectric (composite material made of porogen nano-particles dispersed in a MSQ matrix) is integrated in its non-porous state, preventing integration issues inherent in porous material. The porosity is only created after integration by a final thermal degradation of the porogen phase. Material, curing and processes compatibilities have been studied in order to perform single damascene interconnects. Electrical results prove the feasibility of this approach, showing that the porogen can be preserved during the integration and removed after the integration. [C2639]

"Anodic nano-porous humidity sensing thin films for the commercial and industrial applications"

Presented is a method to make anodic nano-porous humidity sensors using standard integrated circuit processes. These films are proposed as a replacement for polyamide based thin film humidity sensors. Standard titanium tungsten/aluminum multilayer films are deposited using commercial quality deposition equipment onto silicon (100) substrates. Films are anodized in 4% oxalic acid at 40 and 60 volts. Nano-porous humidity sensors are demonstrated that have a factor of 40 difference (dry to wet) in impedance at 20 Hz and a factor of 4 difference at 1 MHz. The complex impedance for saturated and dry films was presented. [C2640]

"Academia-industry collaboration in SoC design education: wishes and reality"

The complexity of IC has been growing each year, now reaching nano-scale design rule and over billion transistors on a chip. To develop advanced SoCs, huge amount and high quality of resources and research activities are necessary for design as well as for technology development. It is getting even more vital to recruit well-trained students, who can lead the global competition. Industry is also expecting for universities to help raise probability of success of SoCs, the market of which is even more limited in time-to-market and product life in spite of the huge investment. These are the major motivations, for which SoC industry wishes to share resources and risk with universities. Industry has even established consortiums to improve and activate the relationship with universities toward these goals. In this panel, views from universities and industry are discussed and analyzed to explore successful collaboration. [C2641]

"Film properties and integration performance of a nano-porous carbon doped oxide"

A porous carbon doped oxide has been developed using a conventional PECVD reactor. Sequential electron beam treatment using a flood beam provides a means for removal of the thermally labile organic species and results in a porous material with high thermal stability. Film properties and integration results presented show the viability of integrating this film into a conventional dual damascene interconnect flow. [C2642]

"Robust multilevel interconnects with a nano-clustering porous low-k (k)"

For 65 nm node devices and beyond, we developed a high performance porous SOD materials, nano-clustering silica (NCS). Our original nano-clustering technique can control pore sizes to less than 2.8nm and achieve a homogenous pore distribution without the use of any template materials. NCS films combine a very low dielectric constant (k) [C2643]

"3-dimensional structures of pores in low-k films observed by quantitative TEM tomograph and their impacts on penetration phenomena"

3-dimensional structures of pores in porous low-k films have been quantitatively observed by transmission electron microscopy (TEM) tomographic technique for the first time. The 3-dimensional (3-D) reconstruction images clarified that the shape of pores are distorted and connectivity of the pores, such as open or close pores, depended on pore formation technique in the films, e.g. template or nano-clustering technique. Quantitative information of pores structure from 3-D reconstruction images were obtained using a 3-D structure analysis algorithm. The size of pores and connectivity influenced on metal penetration into the pores during atomic layer deposition (ALD) and chemical penetration which resulted in void formation in porous low-k films. [C2644]

"Process variation in nano-scale memories: failure analysis and process tolerant architecture"

In this paper, we analyze the impact of process variation on the different failure mechanisms in SRAM cells. We also propose a process tolerant cache architecture suitable for high performance memory. This technique surpasses all the contemporary fault tolerant schemes such as row/column redundancy and ECC in handling failures due to process variation. Experimental results on a 64K cache show that the proposed technique can achieve 94% yield compared to its original 33% yield (standard cache) in 45nm predictive technology. [C2645]

"Power subsystem design for the Lviv Institute Space Apparatus (LISA) nanosat class satellite"

In the paper the COTS-technology application under the nano-satellite power subsystem development with applying the maximum power selection method. In This work the electrical power subsystem for the low orbit nano-satellite development with the earth ionosphere electromagnetic sensing is considered. Power subsystem is developed on the basis of high reliable, nonradiation resistant industrial components (COTS). [C2646]

"Nanometer-scale structures"

Summary form only given. This plenary will discuss how we view nanotechnology and its future impact on information technologies. It will show how in twelve years we have progressed from the birth event of nanotechnology, the manipulation of individual atoms, to demonstrating the first logic circuits in which all of the components are at the nanometer length scale. It will conclude with a sobering look at nano hysteria. [C2647]

"Session 3D: Algorithms and Modeling Techniques for Bio and Nano Technologies"

{no data available} [C2648]

"Fractal dimension of semiconducting fractal sensors"

Metal oxides are used for analysis of gas in the air in nano-dispersion semiconducting sensors developed in recent years. The fractal dimension of such a semiconductor sufficiently influences the character of the electrical conductivity and hence the sensitivity and operating speed of the sensor. The work considers the fractal properties of the structure of the sensitive weight of a semiconductor sensitive element (SE) for the detection of dangerous gas molecules. The way of defining the fractal dimension of the sensitive weight is shown by means of resistance measurement at high frequencies. [C2649]

"Robust tracking control of a novel piezodriven monolithic flexure-hinge stage"

This study presents the controller design and tests of a piezo-driven system for precision motion of a novel two degree-of-freedom (DOF) monolithic stage. The computer-controlled system was developed, designed and employed for better displacement error compensation by PID controller based on internal model control (IMC), iterative learning control (ILC) and disturbance observer (DO). Experiments results show that stage positioning is precisely controlled (error $\approx 1.42\%$) for tracking sinusoidal waveforms by IMC and P-type ILC with repeatable disturbance. With additional DO, experiment tests perform error $\approx 0.5\%$ with non repeatable disturbance up to 16% of the maximum traveling length by in roughly 5 iterations. This is close to the hardware reproducibility level. Experimental results show the piezo-stage control system can be potentially used for nano technology applications for precision engineering in industrial systems. [C2650]

"Design and verification of a mechanical system for magnetospheric mapping missions"

This paper describes the design and qualification of the Space Technology 5 spacecraft mechanical system. Key points include: testing results for the "Frisbee" type deployer system, which imparts a precise spin rate to the spacecraft; layout of the structural bus, with emphasis on design for both compactness and accessibility during assembly; design of the electronics housing, which serves an important dual purpose as the spacecraft structural backbone. Also included is a description of its special accommodations for electrical harness and the integration process; electro-mechanical aspects of the separation connectors and shape-memory-actuated pin pullers; unique challenges due to limited volume and resources were overcome through extensive testing and "skunkworks" type development procedures. Overall, this paper encompasses the unique mechanical system design innovations to enable the 25 kg, fully functional Space Technology 5 spacecraft to blaze a trail towards scale-reduction and system functional integration for upcoming nano-satellite constellations. [C2651]

"Lest we forget: NVSM from origins to the "beyond CMOS" era"

The nonvolatile semiconductor memory (NVSM) technical community has witnessed great progress in the past four decades, and is currently looking at the challenge of finding specific technologies that will be compatible with nano-scale CMOS. In this brief review, efforts to explore new memory alternatives was examined in historical context, and an invitation was extended for volunteers to provide inputs to this project. Nonvolatile semiconductor memory (NVSM) is going through transitions in technology and in market applications that require examination of alternative approaches. In the background of this ongoing competition is the International Technology Roadmap for Semiconductors (ITRS). The ITRS outlines the boundary conditions and parameters for successive generations of memory capable of maintaining historical growth rates for density. The ITRS, that once tracked only a few parameters for flash memory, has expanded the depth of coverage for flash and is now including a number of alternative technologies. In addition, a relatively new portion of the ITRS is devoted to emerging research devices (ERD). The ERD attempts to identify technologies that are in the research stage of maturity and examine whether those technologies have the potential to play a part in the integrated circuit systems that are expected to appear after the anticipated breakdown of conventional CMOS scaling. While this dynamic is a leading edge subject commanding the attention of a world wide community of technologists, it is not true that the task is entirely new; there are many similarities in the history of NVSM to the present situation. Looking back at the issues and state of research and development over the past five decades reveals that we solve what appears to be the same problem over and over again. The difference is that we approach these problems in the context of the current state of technology, and each re-invention of the wheel represents a new set of compromises to achieve practical systems. The tabulations and discussions presented in the ITRS are a composite of technical inputs from many highly qualified individuals. The mechanics of how this information is developed was described. This is to some extent a volunteer effort, and the participation of additional scientists and engineers is sought in the model developments and critiques for individual NVSM technologies. Interested persons are encouraged to express willingness to help by sending an email message that briefly describes their technical background and specific NVSM technology expertise. [C2652]

"ICCAD 2004. International Conference on Computer Aided Design (IEEE Cat. No.04CH37606)"

{no data available} [C2653]

"I-CONE® for rapid response and low cost access to space"

I-CONE® is an innovative approach to providing payload launch opportunities while at the same time taking advantage of the excess launch vehicle performance available with the evolved expendable launch vehicle (EELV). The genesis of the I-CONE® concept is the integration of a standard set of space vehicle subsystems into a standard conical launch vehicle adapter, in effect creating an "intelligent cone" or I-CONE®. The I-CONE® is capable of providing payloads and small satellites a fast, frequent, flexible and affordable (F3A) access to space. The I-CONE® concept is designed for use with the Delta IV and Atlas V (EELV) and is compatible with Delta II and sea launch vehicles. The main I-CONE® structural components are derived from flight heritage payload adapters and separation systems, developed by Saab Ericsson (SE) Space, which minimizes the development risks and production costs. I-CONE® space vehicles can be essentially transparent to the primary payload of a typical EELV manifest. The launch site processing flow for an I-CONE® has a "no impact" approach on the standard EELV primary payload processing flow. The I-CONE® space vehicle concept is suited for a wide variety of technology demonstration and short-term operational missions. The baseline concept features typical payload resources of a 100 kg of mass, with 150 Watts of orbit average power, and a standard downlink data rate of 2.0 Mbps. The baseline I-CONE® space vehicle is capable of providing a pointing accuracy of 10-50 arcsec, a propulsion system with 90 kg of mono-propellant hydrazine, and a mission life exceeding 1 year. The use of I-CONE® for low earth orbit (LEO) missions is emphasized in this paper, although geosynchronous transfer orbit (GTO) launch opportunities are also presented. The modular approach to the I-CONE® space vehicle structure permits an extraordinary level of flexibility for meeting emerging specialized launch requirements. Micro-and nano-satellites can also be accommodated in an I-CONE® variation that incorporates a dispenser. Variations on the I-CONE® dispenser theme include a passive dispenser that provides additional propulsion and attitude control after separation from the launch vehicle. The I-CONE® concept can argument the potential return on investment for any EELV launch as it provides a cost effective and flexible solution for national interests. This paper presents what needs the I-CONE® design addresses for access to space. This paper also provides the generic mission requirements for the I-CONE® design, describes baseline I-CONE® implementation architecture, discusses payload accommodations and generic integration and test flow. Finally this paper discusses potential mission designs which I-CONE® can be applied. [C2654]

"Nano-scale MOSFETs with programmable virtual source/drain"

In this work, we fabricated twin silicon-oxide-nitride-oxide-silicon (SONOS) memory (TSM) cell transistors, based on the 90 nm non-volatile memory technology and showed the implementation of programmable threshold voltage (V_{th}) MOSFETs in the nano-scale regime. It was clearly observed that the transistor has high I_{on}/I_{off} ratio ($>10^6$) and small drain leakage (< 10 pA) in the 30 nm regime. From the experimental result from fabricated devices, it can be deduced that the TSM transistor has various MOSFET applications due to charged states in the nitride. To evaluate the various MOSFET applications of the TSM transistor in the nano-scale regime, the simulation of a 30 nm-long gate TSM transistor was carried out on the 2D ATLAS, including tunneling and impact ionization models. It is concluded that the proposed TSM MOSFET structure promises a well-controlled short channel effect and high I_{on}/I_{off} characteristics. [C2655]

"Nanotube memories for space applications"

The radiation hardness characteristics of nano-electromechanical single-walled carbon nanotube (SWNT) memory elements has been studied. The NRAM bits have been exposed to 100 krad, 1 Mrad and 10 Mrad of gamma-radiation. Initial test results indicate that NRAM is an extremely radiation hard memory. [C2656]

"Characterization approaches of nanoscale modified plastics"

Miniaturization in automotive electronics forces to reduce the size of filler particles in plastics, even to nano scale dimensions. R&D processes as well as later production quality control demand suitable tools and procedures to characterize nano filler particles in polymeric composites. The authors studied different SFM, FIB and SEM based methods of nano particle detection, imaging and quantification. Different scanning probe microscopy (SPM) modes have been compared to each other and to SEM/FIB imaging with regard to their suitability for nano filler characterization in plastics. The influence of surface finishing by focused ion beam (FIB) smoothing is analyzed with emphasis to subsequent quantitative characterization of filler content and distribution. SEM, FIB and SFM load state images have been utilized to measure deformation fields with nano and subnano resolution. The according nanoDAC method is intended to be used for studying fracture mechanisms in the very vicinity of crack tips in nanoscale modified plastics. [C2657]

"Ultra-high density optical data storage"

Results on the use of C-shaped nano-apertures for optical data storage are reported. This type of aperture have a highly concentrated nanometer sized spot with a power throughput 1,000,000 times higher than for a square or round aperture producing the same spot size. Optical recording using contact media and conventional optical read-write media in DVD technology is also described. [C2658]

"Vertical profile design and transit time analysis of nano-scale SiGe HBTs for Terahertz fT"

We present a nano-scale SiGe HBT design for above Terahertz fT. The graded profile is shown to produce better performance than the box profile with the same total Ge (and hence film stability). A 2000 GHz·V fT·VCEOs is shown in simulations using the graded Ge profile. [C2659]

"Two-photon 3D lithography: materials and applications"

This study demonstrates the fabrication of a representative set of microstructures based on the three classes of two-photon photoactive materials compositions. Such structures can be used directly for suitable applications but can also be used as templates for the growth or molding of other materials as needed for a specific application. Given the ability of the two-photon lithography to produce 3D patterns of arbitrary structure, there is potential for the fabrication of an essentially limitless number of micro- and nano-structures in a wide variety of materials compositions. [C2660]

"Absorption of light by plasmons in a nanoporous metal slab"

We have calculated the absorption spectra of a metal surface with a two-dimensional lattice of spherical voids beneath the surface. It is shown that almost total resonant absorption of light occurs at the plasma resonance in the visible when the inter-void spacing and void lattice depth in the metal substrate are thinner than the skin depth, which ensures the optimal coupling of void plasmons to external light. We conclude that the absorption and local-field properties of a nanoporous metal surface can be effectively tuned by nano-engineering of spherical pores. This makes the nanoporous metal surface very attractive for various applications in future submicron light technology. [C2661]

"Optimizing the third-order optical susceptibility of Pt-doped BaTiO₃ grown by combustion chemical vapor deposition"

Optimization of the nonlinear optical properties of metal nano-cluster films imbedded in a nonlinear host is demonstrated using combustion chemical vapor deposition and subsequent Z-scan analysis. [C2662]

"A simple method to fabricate single electron devices"

A simple method, based on overlapping the dosage distribution of the discretely electron beam written nano-dots, was employed to fabricate nano-structure containing narrow constrictions. From the appropriately designed electron beam process, the electron dosage in the overlapping region is just above the threshold exposure dosage of the negative electronbeam resist. A Si-based nano-dot with two narrow tunnel junctions called single electron transistor was formed after dry etching and thermal oxidation process since the overlapping region is much narrower than the diameter of the nano-dot. The electric characteristic of the SET was found to be consistent with the expected behavior of electron transport through a gated quantum dot. Also, the characteristic phase diagrams of double dot structure were obtained by independently sweeping two gates. The honeycomb lattice of the conductance resonances in the phase diagram was modeled using a capacitance equivalent circuit and the electronic behavior of the double dot device was discussed from measured charging diagram comparing with the model. [C2663]

"Schottky barrier behavior of metallic multi-wall carbon nanotube-on-metal systems"

The integration of carbon nanotubes (CNT) into state-of-the-art microelectronic systems as interconnects has thus far proven to be difficult from a processing standpoint. Minimizing contact resistance between the macro-scale metal contact and nano-scale tube continues to be a barrier for the implementation of CNTs into silicon-based technology. This work demonstrates fundamental electrical measurements of side-contacted carbon nanotubes showing Schottky barrier (SB) characteristics in metallic multi-wall nanotube (MWNT) systems. The measurement and insight provided here prove useful in understanding interfacial effects of CNTs and enable us to develop useful methods for integrating these structures into interconnect designs. [C2664]

"Design and simulation of magnetically controlled nanoscale assembly"

New technology, referred to by the acronym MAGDA (magnetically driven assembly), for building multi-component systems out of diverse types of nanodevices, is being developed. One setup employs colloidal magnetic particles as carriers of different nano-components. These carriers are directed by arrays of programmable ferromagnetic nano-traps and by an external magnetic field. Another setup involves magnetic masks formed by 5-10 nm iron oxide particles densifying over an array of magnetized alignment marks. On the simulation side, new "flexible approximation" methods with a wide range of nano- and molecular scale applications are presented. [C2665]

"Quantum mechanical and transport aspects of resolving discrete charges in nano-CMOS device simulation"

We present pragmatic approaches which allow coherent treatment of individual discrete charges in the simulation of nanoscaled MOSFETs. The quantum confinement aspects associated with the Coulomb potential well of individual charges (dopants and/or trapped carriers) are treated using the density gradient approach applied to both the channel and the bulk carriers in a drift diffusion framework. The Coulomb scattering from individual charges is treated through the real space trajectories of the carriers in a Monte Carlo framework applying short range corrections to the mesh calculated forces. The two techniques are joined together in frozen field 'atomistic' simulations of decanano MOSFETs. [C2666]

"A biomedical bone nano-transducer"

Bones are now considered as a well accepted series of piezoelectric materials. Several researchers have used the bone material to develop piezoelectric sensors for the measurement of pressure, force, acceleration and other such parameters. However, with the advancement of technology in sensor systems, micro and nano-scale devices are now being developed by using semiconductor or biological materials, all over the world. Bio-chips based on DNA, and bio-MEMS, etc are some of the examples. In this present research, new bone chips have been developed for various sensor applications, mainly micro or nanoscale systems. Design and fabrication aspects of the bone sensor chips for nano-transducers are discussed in detail here. Possible biomedical applications of these chips are also given in brief. [C2667]

"Freely suspended nanostructure with no substrate beneath: fabrication and optical imaging"

Nano electromechanical systems (NEMS) were fabricated out of silicon on insulator material. The NEMS structures were reliably located on top of a hole leading through the whole substrate etched using bulk processing. The structures therefore are fully freely suspended and thus have no substrate beneath them that could interfere with the NEMS operation, e.g. electrostatically. Structures of $10\ \mu\text{m} \times 200\ \text{nm} \times 120\ \text{nm}$ were fabricated. Confocal optical microscopy was used to image these nanostructures. Despite the wavelength of 635 nm, the structures of 200 nm width were clearly resolved and a separation of about 200 nm between two beams could also be roughly identified. In contrast to scanning electron microscopy (SEM) imaging, the optical imaging is absolutely damage free and can be easily carried out under ambient conditions. [C2668]

"Improvement of thermal stability of Ni germano-silicide for nano-scale CMOS technology"

In this paper, to enhance the thermal stability of the Ni germano-silicide especially on the doped substrate, various kinds of tri-layer structures of Ti/Ni/TiN, Ni/Ti/TiN, Co/Ni/TiN and Ni/Co/TiN were applied. Contrary to the conventional Ni silicide, two-step RTP is also applied to enhance the thermal stability of Ni germano-silicide. Among these structures, a highly stable Ni germano-silicide can be formed by Ni/Co/TiN with high Co concentration along with 2-step RTP. Co/Ni/TiN and Ti/Ni/TiN, especially Co/Ni/TiN with high Co concentration using 2-step RTP, are found to be effective in preventing the abnormal increase of sheet resistance on the As doped substrate during post-silicidation annealing higher than 613°C. [C2669]

"Two and three dimensional MOSFETs simulation with density gradient model"

A 2D and 3D density gradient model is described. Drain current characteristics taking quantum effects into consideration are simulated for extremely scaled bulk nMOSFETs with nanometer channel length and decananoscale tri-gate FinFETs. [C2670]

"Three-dimensional nanoscale manipulation and manufacturing using proximal probes: controlled pulling of polymer micro/nanofibers"

Besides imaging and characterization, proximal probes are proposed to be use as a three-dimensional (3D)

nanoscale manipulation and manufacturing tool. In this work, we propose 3D nanoscale pulling of liquid polymer micro/nanofibers by precise positioning of atomic force microscope (AFM) nanoprobe and control of polymer solidification. An AFM probe is used to pull or extrude thermoset or thermoplastic polymers precisely to fabricate 3D polymer micro/nano-fiber structures. A liquid polymer fiber bridge between the probe tip and a substrate is maintained when pulling the probe from the surface with controlled speed and position. We present results of our pulling experiments in vertical, horizontal and arbitrary 3D pulling directions for PMMA polymer fibers. Implications and future directions are discussed. This micro/nano-fiber pulling technology would have wide applications in nano-circuit interconnects, prototyping novel nano-electronic devices, 3D polymer fiber based nano-actuators, photonic devices, and novel smart sensors and materials. [C2671]

"An algorithm for nano-pipelining of circuits and architectures for a nanotechnology"

In this paper, we describe an algorithm to post-process a register-transfer level (RTL) architecture to enable gate-level pipelining or nano-pipelining for the nanotechnology based on resonant tunneling diodes (RTDs). Nano-pipelining offers the opportunity to obtain massive throughput and, therefore, has applications in data-intensive algorithms such as digital signal processing (DSP). Since RTDs are a self-latching nanotechnology, nano-pipelining is an implicit property that should be exploited for this technology. The novelty of this work lies in exploring and demonstrating the benefits of nano-pipelining and presenting an algorithm for architectural nano-pipelining. [C2672]

"From chemical building blocks of polymers to microelectronics reliability"

Among various materials, polymers are widely used in microelectronics as different product constituents, such as encapsulants, conductive or non-conductive adhesives, underfills, molding compounds, insulators, dielectrics, and coatings. The behavior of these polymer constituents determines the performance, such as functionality and reliability, of the final products. Therefore, the successful development of microelectronics depends on, to some extent, the optimal design and processing of polymer materials. Due to the development trends of microelectronics, characterized mainly by ongoing miniaturization down to the nano scale, technology and functionality integration, eco-designing, shorter-time-to-market, development and application of polymers become one of the bottlenecks for the microelectronic industry. Aiming at optimizing the product/process development, much effort is directed to understanding and designing polymer behavior in microelectronics, such as in material pre-selection, processing, characterization and modeling. Although these efforts are necessary, the ultimate benefits can only be realized if the relationship between chemistry and the behavior can be understood and predicted. This paper presents some results of our effort to establish the links between chemical details of the polymers and microelectronics reliability. [C2673]

"Elevated temperature plasma doping technology for sub-50 nm SOI n-MOSFETs"

A novel plasma doping technique for fabricating a nano-scale silicon-on-insulator (SOI) MOSFETs have been investigated. The S/D extensions of the tri-gate structure. SOI n-MOSFETs were formed by using elevated temperature plasma doping method. The activation annealing after plasma doping was excluded to minimize the diffusion of dopants, which resulted in laterally abrupt S/D junction. We obtained low damage shallow junctions and sheet resistance of $920 \Omega / \text{square}$; by the elevated temperature plasma doping of 527°C . A tri-gate structure SOT n-MOSFET with a gate length of Sub-50 nm was successfully fabricated and revealed suppressed short channel effects. [C2674]

"A nano-liter bio-material spotting system for bio-chip microarray fabrication"

This paper proposes an integrated nano-liter bio-material spotting system. The system can be used for DNA gene-chip microarray, protein microarray and other chemical microarray fabrication. The system features a fixed print head, which significantly reduces spotting position and spot size uniformity variations. The system also features a unique spotting pin and print head alignment system design. [C2675]

"Verification of NASA emergent systems"

NASA is studying advanced technologies for a future robotic exploration mission to the asteroid belt. This mission, the prospective ANTS (Autonomous Nano Technology Swarm) mission, will comprise of 1,000 autonomous robotic agents designed to cooperate in asteroid exploration. The emergent properties of swarm type missions make them powerful, but at the same time are more difficult to design and assure that the proper behaviors will emerge. We are currently investigating formal methods and techniques for verification and validation of future swarm-based missions. The advantage of using formal methods is their ability to mathematically assure the behavior of a swarm, emergent or otherwise. The ANT mission is being used as an example and case study for swarm-based missions for which to experiment and test current formal methods with

intelligent swarms. Using the ANTS mission, we have evaluated multiple formal methods to determine their effectiveness in modeling and assuring swarm behavior. [C2676]

"Verification of emergent behaviors in swarm-based systems"

The emergent properties of swarms make swarm-based missions powerful, but at the same time more difficult to design and to assure that the proper behaviors emerge. We are currently investigating formal methods and techniques for verification and validation of swarm-based missions. The Autonomous Nano-Technology Swarm (ANTS) mission is being used as an example and case study for swarm-based missions to experiment and test current formal methods with intelligent swarms. Using the ANTS mission, we have evaluated multiple formal methods to determine their effectiveness in modeling and assuring swarm behavior. This paper introduces how intelligent swarm technology is being proposed for NASA missions, and gives the results of a comparison of several formal methods and approaches for specifying intelligent swarm-based systems and their effectiveness for predicting emergent behavior. [C2677]

"Asteroid exploration with autonomic systems"

NASA is studying advanced technologies for a future robotic exploration mission to the asteroid belt. The prospective ANTS (Autonomous Nano Technology Swarm) mission comprises autonomous agents including "worker" agents (small spacecraft) designed to cooperate in asteroid exploration under the overall authority of at least one "ruler" agent (a larger spacecraft) whose goal is to cause science data to be returned to Earth. The ANTS team (ruler plus workers and messenger agents), but not necessarily any individual on the team, exhibit behaviors that qualify it as an autonomic system, where an autonomic system is defined as a system that self-reconfigures, self-optimizes, self-heals, and self-protects. Autonomic system concepts lead naturally to realistic, scalable architectures rich in capabilities and behaviors. In-depth consideration of a major mission like ANTS in terms of autonomic systems brings new insights into alternative definitions of autonomic behavior. This paper gives an overview of the ANTS mission and discusses the autonomic properties of the mission. [C2678]

"Test chip for the development and evaluation of test structures for measuring stress in metal interconnect"

The development of a new test chip is presented, which contains the first test devices able to directly measure stress in metallic interconnect layers associated with silicon IC technology. The rotation of the structures provides a simple method of differentiating between tensile and compressive stress. This test chip has been used to fabricate working devices allowing the study of stresses in aluminium layers before and after sample sintering. The results are presented along with the design, fabrication and measurement considerations that have arisen during the research. Also discussed are the problems experienced with residual sacrificial layer material and the potential solutions that are under investigation. The sensor device is CMOS-compatible and its inherent scalability makes it suitable for in-line testing of state-of-the-art devices. [C2679]

"Improved yields for the nano-technology era using cryogenic aerosols"

In this paper, cryogenic aerosol processing for enhancing final device yield in state-of-art 180 and 130 nm devices is demonstrated. Significant advantages of this particle removal technology is demonstrated and discussed: excellent particle removal efficiency on both hydrophilic and hydrophobic surfaces, no watermarks, no feature damage, no charge induced damage and no film modification or loss. [C2680]

"Investigation of nano interconnects for an early experimental assessment of future interconnect challenges"

The investigation of interconnects with CDs of future technology nodes is limited to direct writing techniques for pattern definition, as next generation lithography is still under investigation. To by-pass the throughput limitations of direct writing, allowing the fabrication of only a limited number of test structures for process adaptations and electrical characterization, alternative approaches were developed. Standard stepper manufacturing lithography was used in combination with additional process tricks to fabricate a large number of test structures across the wafers with CDs down to 20nm, however, at the expense of a relaxed pitch. For a study of the scaling limits of copper damascene and subtractive aluminium metallization, a removable spacer technique and a hard mask trim were developed, respectively. Thus damascene trenches and RIE-masks with deep sub-100nm CDs could be prepared. The electrical characterization of Cu nano interconnects shows that the ITRS requirement for the conductor resistivity will not be met, not even with cooling, in future technology generations. The ITRS red brick wall for barrier films, however, is getting cracks. Barrier functionality with film thicknesses below end-of-roadmap thickness requirements was demonstrated with excellent barrier integrity regarding line-to-line leakage after

anneals and after excessive BTS tests. First results on electromigration behaviour of Cu nano interconnects are also encouraging. Results on Al are underway. [C2681]

"Three-dimensional nanofabrication (3D-NANO) down to 10-NM order using electron-beam lithography"

We have devised a new technology for 10-nm-order three-dimensional nanofabrication (3D-NANO) by electron-beam nanolithography (EBL) that involves repeating the e-beam exposure, rotation, and if necessary, other processes like development and etching. 3D-NANO was achieved through the combination of a rotation drive in the EBL apparatus, a focusing system, and a beam positioning method that uses the transmission signal to provide an accuracy of 10-nm order. The fabrication of a nanofilter and nanopillars on a sphere have demonstrated that our 3D-NANO technique can create 3D structures with a resolution on the order of 10 nm and a high degree of freedom. It should have many applications in biology, chemistry, medicine, nanoelectronics, and nano-machining. [C2682]

"Assembly technology across multiple length scales from the micro-scale to the nano-scale"

Directed microassembly and nanoassembly is performed by using appropriately-sized end-effectors coupled to macro-robotic systems. The larger end-effectors are made via microelectromechanical systems (MEMS) fabrication processes and can handle components ranging from hundreds of microns in size down to ten nanometers. Smaller end-effectors are etched tungsten probes capable of manipulating nano-scale objects. We demonstrate automated and semi-automated microscale assembly while nanoscale assembly is currently done only in semi-automated ways. Resultant assembled devices include three-dimensional MEMS assemblies and carbon nanotube structures. [C2683]

"Reactive oxide micro molding of diffractive optical elements in glass and transparent ceramics"

We present a new chemical process that we call 'Reactive Oxide Micro Molding' (ROMIM), for the realization of micro-optical components in glass and transparent, high dielectric ceramics for Micro-Opto-Electro-Mechanical System applications. The technology is based on an original chemical route to prepare a stable solution of reactive oxide nano-particles and reactive oxide-oligomer units at very high concentration. Thermal processing triggers a reactive agglomeration amongst these reactive species without causing defects and cracks, thanks to both the high density of the solution and the absence of organic material. The final result is a pure glass or ceramic structure without inclusion of organic materials. [C2684]

"Nano-electronics and nano-computing: status, prospects, and challenges"

Nano-electronics is an emerging area of electrical and computer engineering that concerns itself with the study of building electronic devices at nanometer dimensions. This paper is a review of the current state of nano-electronics and nanocomputing technologies, and it also evaluates the prospects and the challenges that must be overcome for commercial realization of nano-electronic products. It is hoped that this paper would serve as a good starting point for those who want to explore this area and would like to know the status of the technology, the issues, the challenges, and research opportunities. [C2685]

"Defects and faults in quantum cellular automata at nano scale"

There has been considerable research on quantum dot cellular automata (QCA) as a new computing scheme in the nano-scale regimes. The basic logic element of this technology is majority voter. In this paper, a detailed simulation-based characterization of QCA defects and study of their effects at logic-level are presented. Testing of these devices is investigated and compared with conventional CMOS-based designs. Unique testing features of designs based on this technology are presented and interesting properties have been identified. [C2686]

"High aspect ratio nanovolume glass cell array fabricated by area-selective silicon electrochemical etching process"

Fabrication of arrays of high aspect ratio nanovolume glass (SiO₂) cells or "test tubes" by using electrochemical process was attempted, which could be applied to various micro scale and nano scale systems. By applying a shield mask to the backside of the wafer to control the illumination condition of the light, which generates the hole, area selective anodization process was developed to form arrays of the straight micropores at the selected region of the Si surface. Then the surface of the micropores was thermally oxidized to form SiO₂ layer and bulk Si region was partially removed by alkaline etching to expose the array of freestanding, SiO₂ hollow tubes. [C2687]

"Influence of nanosilica on composite underfill properties in flip chip packaging"

The nanosilica filled composite is a promising material as the no-flow underfill in flip-chip application. However, as the filler size decreases into the nano level, the rheological, mechanical, dielectric and thermal mechanical properties of the composite change significantly. The filler-filler and filler-polymer interactions have a profound impact on the material properties. The purpose of this paper is to achieve an in-depth understanding in the effect of the filler size and surface on material properties and therefore to provide guidance for the design of nanocomposite in no-flow underfill applications. Mono-dispersed nanosilica fillers of 100 nm in size were used in this study. An epoxy/anhydride mixture was used as the base resin formulation. Control samples with micron-size silica fillers were also formulated and characterized for comparison. [C2688]

"Power awareness and energy efficiency in portable instrument networks"

Today's electronic portable instruments are highly sophisticated and are fully utilising advanced electronic components, sensors, and communications technologies. Many modern portable instruments are complex in their functionalities using multisensors and also can communicate with each other or other digital devices under stand alone operational modes. The progress in digital hardware, intelligent sensors, nano and microsensors, and software add remarkable features to these devices. As portable instruments get complex the efficient use of power and their power related reliability becomes a central issue. Power awareness and energy efficiency starts at the sensor level and builds up towards a much more complex system. This paper discusses power management and energy efficiency in portable instruments and gives examples on the energy efficient designs. [C2689]

"Why nano technology? Why now? And what might its impact on electronics"

{no data available} [C2690]

"Testing of quantum dot cellular automata based designs"

There has been considerable research on quantum dots cellular automata as a new computing scheme in the nano-scale regimes. The basic logic element of this technology is a majority voter. In this paper, testing of these devices is investigated and compared with conventional CMOS-based designs. A testing technique is presented; it requires only a constant number of test vectors to achieve 100% fault coverage with respect to the fault list of the original design. A design-for-test scheme is also presented which results in the generation of a reduced test set. [C2691]

"Effects of the low loss polymers on the dielectric behavior of novel aluminum-filled high-k nano-composites"

Passive components, active components, and interconnecting substrates are the fundamental building blocks for an electronic system, and nowadays, a large percentage of the printed circuit board (PCB) surface area is taken up by the surface-mounted discrete passive components. Embedding these discrete components into the board structure has become the primary method to further miniaturize electronic systems. Besides the size reduction, embedded passives offer many other advantages. Reduced cost and improved electrical performance can be expected, and are actually another two major driving forces of embedded passive technology. To enable embedded passives, materials that satisfy the requirements of fabrication, electrical performance, and mechanical performance need to be developed. We report the innovative development of a low-cost high dielectric constant polymer-based composite that combines the advantages of polymer-ceramic and polymer-metal systems for embedded capacitor application. This novel material uses low cost self-passivated aluminum particles as the filler for the polymer composites. The thin self-passivated Al₂O₃ layer forms a nanoscale insulating boundary outside of the metallic spheres, which has dramatic influence on the electrical behavior of the resulting composites. The nanoscale insulating oxide layer allows the aluminum composites to have a high dielectric constant as a percolation system; on the other hand, the insulating oxide layer confines the electrons within an aluminum particle, thus keeping a very low loss of the composites. [C2692]

"Material and process challenges in embedding polymeric waveguides and detectors in system on package (SOP)"

Polymer materials are becoming increasingly important for integrated optics, in part due to the easy and low cost manufacturability. Embedded polymer waveguides and other polymer devices such as gratings, micro lenses, switches, splitters, etc. are increasingly used in packages and printed wiring boards (PWBs) for optical interconnection and are becoming an emerging technology to enable high data rates over centimeter lengths on-

board. A nano scale local surface roughness is desirable for the implementation of these devices in order to avoid unnecessary optical losses. Yet it is a great challenge to control surface roughness on PWB surfaces to the nanometer scale over distances of a millimeter. In addition, board flexibility, lack of planarity, and thermal expansion create great challenges for the implementation of integrated digital-optical technology on packages or boards. A buffer layer produced by a low cost process and which results in a nano scale local roughness is a critical solution that enables the integration of low loss waveguides and other optical passives on boards. It is one of the objectives of this article to demonstrate how to reduce the "as received" surface roughness of a HDI board, which may additionally contain metal lines up to 18 μm thick, to a roughness of ± 20 nm in general and to ± 5 nm or less in special cases over distances of 500 μm . We will also discuss fabrication of low loss, low multimode waveguides with 0.24 dB/cm at 1.32 μm and 0.52 dB/cm at 1.55 μm , as well as other optical passives such as micro lenses having 50-250 μm base diameter and 80 to 200 μm focal length, surface relief gratings with 250 lines/mm and a 35-degree blaze angle, micro mirrors, as well embedded photo detectors, including I-MSM thin film detectors and off-the-shelf PIN bare die detectors. Finally, metallization of bonding pads structures on waveguide polymer material will also be discussed. [C2693]

"Material synthesis routes for thin film bonding interfaces in reworkable and bumpless nano-interconnects"

This work explores novel material synthesis routes towards reworkable nano-dimensional interfaces for IC-package assembly, leading to bumpless and nano interconnections. Reworkability is addressed by a thin interface of lead-free high-strength solders. Two approaches, sol-gel process and electroless plating, were used to achieve these nano-dimensional bonding interfaces. In the sol-gel process, metal-organic polymer solutions were heat-treated in a reducing atmosphere at 400°C to form lead-free solders (Sn-Ag-Cu). In the electroless plating approach, lead-free alloy films were deposited from aqueous plating solutions consisting of suitable metal salts and reducing agents. This process was done at a temperature of 45°C. The lead-free solder composition was controlled by altering the plating bath formulation. Solder films formed from both the above approaches were demonstrated to bond copper pads. Solution-derived nano-solder technology is an attractive low-cost method for bumpless nano-interconnects and other applications such as MEMS hermetic packaging and compliant interconnect bonding. [C2694]

"Design optimization and reliability of PWB level electronic package"

As the Electronic Packaging industry develops technologies for fabrication of smaller, faster, economical and reliable products; thermal management and design play an important role. The major part of the failures of the electronic components is temperature related. During thermal cycling, fatigue failures are caused due to mismatch of coefficient of thermal expansion (CTE) of different materials present in the components. Increased power dissipation and density in modern electronics system require efficient and intelligent design and thermal management strategies to ensure the reliability of electronic products. This paper discusses the reliability and design optimization of a generic Printed Wiring Board (PWB) level electronic package under thermal cycle loading. Finite element tool ANSYS is used to estimate the cycles to fatigue failure of solder joint of the package coupled with optimization module present in ANSYS for providing the details on determining optimal design parameters which affect the product reliability. Combining finite element analysis with optimization would significantly reduce the design time and increases the product reliability. Four model characteristics: PWB core in-plane Young's Modulus, PWB core in-plane coefficient of thermal expansion, PWB core thickness and the stand-off solder joint height are chosen as the optimization inputs (design variables) that ensure higher reliability and improved performance of the assembled product. The objective of the optimization is to improve the fatigue life of solder joints of the package. Sub approximation, Design of Experiment (DoE) and Central Composite Design based Response Surface Modeling Methodology are used to study the effects of each design variables on the fatigue life. [C2695]

"A nano-power tuneable edge-detection circuit"

A useful nanopower circuit is presented for edge detection in integrated vision systems. Based on a compact front-end of only five MOS devices, this circuit features a tunable threshold and discrete output; ideal for interfacing to digital electronics. [C2696]

"Effectiveness of energy recovery techniques in reducing on-chip power density in molecular nano-technologies"

As scaling of silicon devices continues at an aggressive pace, the problems with it are becoming more and more evident. With 'short channel effects' already in the way of scaling interest has shifted to the possible use of non-silicon molecular devices for circuit implementation. Carbon nanotube has emerged as a promising candidate.

However, molecular devices such as carbon nanotube FETs (CNFETs) with their super-scaled dimensions and high current densities would increase the power density on chip and reasonable predictions estimate that they would far exceed the maximum power density limitation as stated in the ITRS (2001). This paper explores the use of energy-recovery techniques in molecular CNFET based digital circuits and demonstrates how they can solve the power density problem in such circuits. [C2697]

"EuroSoC: towards a joint university/industry research infrastructure for system on chip and system in package"

Summary form only given. A strategy for research and development, as well as for product definition and marketing for electronic systems in view of the incoming nano era requires expertise and even excellence in so many diverse areas that even the largest semiconductor industry in the world, INTEL, cannot conceive it in isolation. The worldwide trend is to develop joint program between industry and academia with public and industrial funding sustained over a rather long time horizon to develop methods and technologies to master the difficult art of integrated system design. The central problem to be overcome is that traditional approaches to design and tools will not scale. Moreover, existing designers will not scale too because they do not have the required pluridisciplinary scale to deal with SoC. The strategic direction of EuroSoC is to address these issues by lining up the research community and by providing a framework where its collective knowledge can be fostered and fully leveraged by industry and society in general. [C2698]

"Macro, micro, nano, and beyond-Keynote talk"

{no data available} [C2699]

"Leakage in nano-scale technologies: mechanisms, impact and design considerations"

First Page of the Article [C2700]

"Large scale simulations for carbon nanotubes"

Computational approaches have brought powerful new techniques to understand chemical reactions and material physics as well as experimental and theoretical methods, and they are playing a crucial role in nano technology. Growth in applications of codes enabled us to show the properties of molecular and atoms interacting with surrounding complex environment and new material finding. We developed molecular modeling codes based on tight binding (TB) approach, conventional density functional method (DFT) and time-dependent DFT. These codes have used for many phenomena as the need arose. As for nano material design, we have challenged large scale simulations up to ten thousand atoms without the spatial symmetry and homogeneous condition. The TB method is suitable for treatment of a large number of atoms. Thus at first we concentrated on the TB code for optimizations. The carbon-recursive-technique-molecular-dynamics (CRTBD) is tight binding software specialized for carbon systems with order-N scaling. Through efficient optimization by the parallelization and vectorization on the Earth Simulator, we achieved the performance of 7.1 Tera Flopes on 435 nodes (3480 processors) in the simulation of thermal conductivity of carbon nanotube with 48600 atoms. Earth Simulator could give a possibility of large-scale realistic simulations in finding and creating novel nano materials. [C2701]

"Developing a cryptology algorithm by using wavelet transform"

Since World War II, IT security and cryptology systems have been getting more important day by day. Besides DES and Triple DES of IBM Inc., the RCX series of symmetric algorithms and MD5 variant HASH algorithms of RSA Inc. have been widely used in cryptology research. However, recent technology concepts, such as faster microprocessors, nano-technology and quantum computers, make change inevitable. The wavelet transform method, preferring signal processing and image compression areas, is used as the data scrambling procedure. The results are compared using parameters such as reliability and algorithm speed. [C2702]

"Synthesis of nanocomposite powders in capacitively coupled plasma"

Summary form only given. Medium pressure, (1000-10,000 Pa) capacitively coupled (CC) RF discharges of power density 10-20 W/cm³ were used for the treatment and synthesis of nanopowders in the gas through flow. The discharge was organized to have coaxial geometry within a structure of outer cylindrical electrodes and water-filled coupling capacitors. CC plasma, produced in the reactor fed with hydrocarbon gases, was applied to the in-flight treatment of ceramics nanopowders (TiO₂, SiO₂), introduced as suspension, resulting in nano-thick a-C:H coatings of particles. This type of plasma processing of nanopowders combined with their synthesis can reduce the post-synthesis agglomeration of particles, porosity of the ceramic coatings and can find applications in the development of materials with new properties. Another application for this CC plasma facility is the

possibility of iron/carbon nanostructures synthesis demonstrated using the vapor of iron carbonyl $\text{Fe}(\text{CO})_5$, diluted with argon, as a precursor. The nanostructures consist of iron cores embedded in the cells similar to carbon nanotubes. This is promising in development of nanostructured ferromagnetic materials with new properties (magnetic permeability, hysteresis curve, ferrites' operational frequency etc). [C2703]

"Investigation on the application of the capillary-discharge based metal-vapor generator and the 46.9 nm Ar capillary-discharge soft X-ray laser"

Summary form only given. Here we report on the possible application of the capillary-discharge based plasma sources. Two different types of sources were investigated. In the first of them the plasma was produced inside the capillary between a cathode and a hollow anode by the explosive ablation of electrode material in the high-current μs discharges. High-density ($>10^{19}\text{cm}^{-3}$), pure, small diameter (1-6 mm), long (5-20 cm) metal-vapor columns have been produced. The application of the developed metal-vapor generator for the Z-scaling of the Ne-like soft X-ray laser is expected. The possibility of utilization of the sub-milliradian divergence Ne-like Ar capillary-discharge soft X-ray laser for different application, which involves mainly nano-technology and nano-machining, is also discussed. [C2704]

"A novel highly reliable low-power nano architecture when von Neumann augments Kolmogorov"

This work presents a novel architecture, which is both device and circuit independent. The starting idea is that computations can be performed in three fundamentally different ways: entirely digital (using Boolean gates), entirely analog (using analog circuits), or mixed (using both digital and analog circuits). The boundaries between these are sometimes very thin. As an example, a threshold logic gate is already mixed, i.e. even if the inputs and the output are Boolean, the weighted sum-of-inputs is a multiple-valued logic signal, i.e. a low-precision analog signal. It has already been suggested that, at least for CMOS, a mixed analog/digital approach is the most power-efficient solution. Still, the main disadvantages of using analog circuits are: (i) their more complex (handcrafted) design, and (ii) their (expected) lower reliability (signal-to-noise or precision), which will be exacerbated by scaling. Here, we will show how both these disadvantages could be tackled. A constructive solution for Kolmogorov's superposition and (multi-threshold) threshold logic synthesis could be used for automating the design. Digital or threshold logic circuits will compensate for the accumulation of noise in the cascaded (very) low precision analog circuits. These digital circuits will also contribute to a von Neumann's multiplexing scheme used to augment the defect- and fault-tolerance of the architecture. A few examples will show how this architectural approach could be mapped on top of a given (nano) technology. [C2705]

"Silica microspheres close up: near-field characterization and coupling to nano-emitters"

We use optical near-field techniques to characterize and manipulate high-Q whispering-gallery modes of silica microspheres and to couple them to a single nano-emitter. Furthermore, we study the coupling of two nano-emitters via the whispering-gallery modes and discuss future plans. [C2706]

"A novel cascade-based de-embedding method for on-wafer microwave characterization and automatic measurement"

This paper presents a general S-parameter de-embedding method using only one "OPEN" and one "THRU" dummy structures for on-wafer microwave characterization and automatic measurement. By aggressively combining the transmission-line theory and cascade-configuration concept, this method can efficiently create the scalable and repeatable interconnect parameters to accurately eliminate the redundant parasitics of the device-under-test (DUT). With the application of the proposed technique, both active and passive devices, such as MOSFET, BJT, spiral inductor, and MIM capacitor, can be de-embedded to acquire their intrinsic performances, and the consumption of chip area for on-wafer device characterization can be significantly saved. [C2707]

"Nanolab: a tool for evaluating reliability of defect-tolerant nano architectures"

As silicon manufacturing technology reaches the nanoscale, architectural designs need to accommodate the uncertainty inherent at such scales. These uncertainties are germane in the minuscule dimension of the device, quantum physical effects, reduced noise margins, system energy levels reaching computing thermal limits, manufacturing defects, aging and many other factors. Defect tolerant architectures and their reliability measures gain importance for logic and micro-architecture designs based on nano-scale substrates. Recently, a Markov random field (MRF) has been proposed as a model of computation for nanoscale logic gates. In this paper, we take this approach further by automating this computational scheme and a belief propagation algorithm. We have developed MATLAB based libraries and toolset for fundamental logic gates that can compute output probability distributions and entropies for specified input distributions. Our tool eases evaluation of reliability measures of

combinational logic blocks. The effectiveness of this automation is illustrated in this paper by automatically deriving various reliability results for defect-tolerant architectures, such as triple modular redundancy (TMR), cascaded triple modular redundancy (CTMR) and multi-stage iterations of these. These results are used to analyze trade-offs between reliability and redundancy for these architectural configurations. [C2708]

"Study and characterization on the nanocomposite underfill for flip chip applications"

The purpose of this paper is to achieve an indepth understanding of the effect of the filler size and surface treatment on material properties and therefore to design a nanocomposite formulation with desirable material properties for no-flow underfill applications. Mono-dispersed nanosilica filler of 100 nm in size were used in this study. An epoxy/anhydride mixture was used as the base resin formulation. The nanosilica fillers were incorporated into the resin mixture to different filler loadings from 5 wt% to 40 wt% with or without silane coupling agents as the surface treatment. Compared with micron-size silica, nanosilica did not interfere with the solder joint formation in the no-flow process, and it was transparent to visible light, which can benefit the flip chip assembly. Additionally, the CTE of nanosilica filled underfill was lower than that filled with micron silica at same loading level. However, nano-size filler also had some negative effects on the underfill materials due to large surface areas and interfacial interactions, including reducing the composite Tg, inhibiting the epoxy curing, extremely high viscosity at high loading level, high moisture absorption and low density. However, the results also showed that the compatibility between nanosilica and the epoxy matrix was greatly enhanced by silane modification of the nanosilica surface. Therefore, drawbacks caused by the incompatible interface between nanosilica and the epoxy matrix can be overcome. [C2709]

"A new approach in measuring Cu-EMC adhesion strength by AFM [Celectronics packaging applications]"

The copper-epoxy molding compound (Cu-EMC) interface is known to be one of the weakest interfaces in an electronic package, exhibiting delamination during reliability testing. A thiol compound which bonds readily and forms a self-assembly monolayer (SAM) with copper is proposed to improve interfacial adhesion between copper and EMC. Conventional adhesion evaluation involves force measurement at macro-scale. However, inconclusive or even contradictory results are common in those tests because of uncontrollable surface conditions such as contamination and, in particular, roughness. To eliminate the roughness effect and reflect the true chemical bonding condition, a Si wafer was used as a substrate in the experiments. This study involves the use of an atomic force microscope (AFM) in characterizing the nano-scale adhesion force in the Cu-SAM-EMC system. Findings were used as the criteria in selecting an SAM candidate. A thiol compound having a carbonyl group is shown to be the best adhesion promoter from the measurements. The nano-scale AFM results are shown to be consistent with the results of macro scale shear tests. It has been demonstrated, with SAM treatment on a cleaned Cu surface, the fracture force between Cu-EMC samples is improved from 119 N to 195 N. [C2710]

"Effects of the low loss polymers on the dielectric behavior of novel aluminum-filled high-k nanocomposites [Cembedded capacitor applications]"

We report the innovative development of a low-cost high dielectric constant polymer-based composite that combines the advantages of polymer-ceramic and polymer-metal systems for embedded capacitor application. This novel material uses low cost self-passivated aluminum particles as the filler for the polymer composites. The thin self-passivated Al₂O₃ layer forms a nanoscale insulating boundary outside of the metallic spheres, which has dramatic influence on the electrical behavior of the resulting composites. The nanoscale insulating oxide layer allows the aluminum composites to have a high dielectric constant as a percolation system; on the other hand, the insulating oxide layer confines the electrons within an aluminum particle, thus keeping a very low loss of the composites. Details of both particle and polymer materials are given in this paper. This study may have a broad impact since it reveals a category of new dielectric composites filled by metal with either self-passivated or coated insulating boundary layers. [C2711]

"Thermal insulation using fullerenes"

A novel type of multi-layer vacuum insulation based on carbon nano-materials, namely fullerenes, has been demonstrated. The design is based on unique thermal insulation properties of fullerenes, arising from their electronic structure, as well as proprietary deposition technique using thin layers of reflective material as a support. As a result of experimental testing, the fabricated samples of fullerene-based insulation were shown to possess R-values of 36 to 40 per inch of thickness at cryogenic temperatures, which considerably exceeds those of commonly available insulation materials (for example, polyurethane (R6.7), expanded polystyrene (R3.8), and even vacuum insulated panels (R9-24)). Application of such insulation will result in significant size and weight reduction while maintaining cost-effectiveness. [C2712]

"Electrical and thermal conductivities of polymer composites containing nano-sized particles [Celectronics packaging applications]"

Electrically conductive adhesives (ECAs) have been explored as an environment friendly interconnection technique. While they have many potential advantages for surface mount and flip chip applications, typical ECA materials suffer from several critical issues when used as a drop-in replacement for lead-containing solders. In an attempt to understand and improve the thermomechanical properties of ECA materials, nano-sized silver particles were introduced into the conventional ECA compositions. The influence of nano particles on bulk resistivity is reported in this paper. It was found that the bulk resistivity of ECA formulations strongly depended on the contents of silver flake and nano particles, as well as the particle morphology and surface properties. The thermal conductivity of alumina based composite samples was also affected by the inclusion of nano alumina particles. Both the electrical and thermal conductivities of the polymer composites containing nano particles would be determined by the contacts of micro-sized particles and interfaces that involve nano particles along the conduction paths. [C2713]

"New paradigm in IC package interconnections by reworkable nano-interconnects"

We propose new IC packaging technologies that have the potential to bring about disruptive innovations in interconnect pitch, best electrical and mechanical properties, low-cost and chip size. Current approaches for chip to package interconnections are limited in terms of either pitch or electrical-mechanical trade-off properties. For example, lead free solder interconnects fail mechanically as the pitch is brought down from current 200 micron pitch to 20 micron. Compliant leads, on the other hand, solve mechanical reliability but at the expense of electrical performance. Solution-derived materials for reworkable nano-interconnects can be a viable technology to meet these two challenges. Nano-grained electroplated copper is chosen as the primary interconnect material. Compliancy was addressed by tuning the process to electroplate high-aspect-ratio structures. Reworkability was addressed by a thin, liquid lead-free solder interface between the interconnect and the package. Two approaches, sol-gel and electroless plating were used in this work to deposit these liquid interface films of lead free solders of the order of 50-300 nm. In the sol-gel process, metal-organic polymer solutions were heat-treated in a reducing atmosphere at 300°C to form lead-free solders (Sn-Ag-Cu). In the other approach, lead-free alloy films were deposited from aqueous plating solutions consisting of suitable metal salts and reducing agents. This process was done at temperatures of 45°C. The lead-free solder composition was controlled by altering the plating bath formulation. Lead-free solder films formed from both the above approaches were demonstrated to bond copper pads. Solution-derived nano-solder technology is an attractive low-cost method for bump-less nano-interconnects and other applications such as MEMS hermetic packaging and compliant interconnect bonding. [C2714]

"Fundamental research on surface modification of nano-size silica for underfill applications"

In order to improve the rheological behavior of nanosilica composite no-flow underfill, a filler surface treatment using silane coupling agents was investigated, to reduce the filler-filler interaction and to achieve monodispersity of the nanosilica in the underfill resin. The experimental conditions of the surface treatment were investigated in a DOE in terms of the pre-treatment methods, coupling agent types, concentrations, and treatment durations. The particle dispersion after treatment was evaluated by a laser particle analyzer and TEM. A mono-dispersed nanosilica solution in the polar medium was achieved using optimal experimental conditions. The surface chemistry of the nanosilica was studied using FTIR. The wettability of the underfill resin and water on the silane treated glass slides was studied using a goniometer. Based on the investigations, the silane-treated nanosilica fillers were incorporated into an underfill resin to formulate a nanocomposite no-flow underfill. It was found that a proper filler treatment could significantly reduce the viscosity of the nanocomposite. [C2715]

"A thermodynamic model for electrical current induced damage"

Electromigration induced damage, which is in principal an irreversible mass diffusion under high current density, has been a concern for VLSI design for a long time. Miniaturization of electronic device sizes down to nano-scale will make electromigration a concern for all conducting components. This paper uses thermodynamics, statistical mechanics and mass transport (diffusion) principals to propose a model for electromigration process and a damage evolution model to quantify the degradation in microelectronics (and Micro Electro Mechanical System) solder joints subjected to high current densities. Entropy production in the system is used as a damage metric. The irreversible thermodynamic damage model utilized in this work has previously been successfully applied to thermomechanical fatigue of microelectronic solder joints. In this paper we extend this model to electromigration-induced degradation. Electromigration process is modeled by the atomic vacancy flux (mass diffusion) process. The proposed unified model is compared with several existing analytical and empirical models. A comparison of the damage evolution model proposed in here agrees well with empirical models

proposed in the literature. [C2716]

"Nano metal particles for low temperature interconnect technology"

For low temperature interconnects, melting point (T_m) depression and sintering behavior of metal nano particles are investigated. Nano Ag particles used (20 nm) exhibited obvious sintering behavior, rather than typical melting behavior, at significantly lower temperatures (150 °C) than its T_m (1235°C). The particle surface was characterized by XPS, FTIR and TGA. The thermal behavior was studied by DSC and TGA. The crystal structure of the particle was examined by XRD. The shrinkage of the nano particles during sintering was monitored by TMA. Sintering behavior of the nano particles is discussed. [C2717]

"Generators, antennas and registrator for UWB radar application"

The paper describes the basic elements developed for realization of UWB radar: generators, antennas and registrator. Generators produce UWB signals of nano- and picosecond duration, having the form of a step-like function, a monopulse, or a pulse in the form of sine wave single period (monocycle). Fulfillment of FCC radiation requirements means filtering the UWB signal spectrum, which results in distortions of the waveform. It is shown that filtering sine wave single period pulses of 0.2 ns duration provides slight distortion. A description of a TEM broadband shielded horn antenna with low side and back pattern lobes is given. The registrator for reception of UWB signals and software for secondary signal processing are described. [C2718]

"MEMS composite structures for tunable capacitors and IC-package nano interconnects"

This paper presents novel low-temperature processes that combine high-aspect-ratio polymer structures with electroless copper plating to create laterally compliant MEMS structures. This low-cost processing was developed for two applications: 1) low-voltage comb-drive actuators for tunable capacitors to reduce the tuning voltage in MEMS structures to less than 5 V and simultaneously increase the capacitance in between the electrode fingers; 2) compliant IC-package interconnects for reliable, low-cost and high-performance nano wafer-level packaging. In both situations, metallic structures show limited electrical performance and create severe reliability issues. Analytical modeling was used to show the advantages of novel composite structures. High-aspect ratio structures were fabricated from lithography and plasma etching. Processing of metal-coated polymers is limited by side-wall adhesion of metal to the polymer and polymer adhesion to underlying substrates. While photodefinable polymers can simplify the processing cost, a dry plasma etching process can give more flexibility in the selection of polymers. [C2719]

"Damage mechanics of microelectronics solder joints under high current densities"

The electromigration damage in flip chip solder joints of eutectic Sn/Pb was studied under current stressing. The height of the solder joints was 100 μm . The mass accumulation near anode side and void nucleation near cathode were observed during current stressing. Surface marker movement technique is used to measure the atomic flux driven by electromigration and to calculate the product of effective charge number and diffusivity, DQZ^* , of the solder. Subsequent experiments reveal that the presence of thermomigration due to joule heating makes the extraction of the product of effective charge number and diffusivity erroneous when using marker movement technique. Pb Phase growth is observed under different current density and temperature. Higher current density leads to faster grain coarsening. Based on the test results, a grain coarsening equation including the influence of current density is proposed, $dn - dn_0 = K_j m t$. The current density exponent m is found to be 3, and phase growth exponent n is found to be 5.5. Within our test temperature range, electric current seems to have greater influences on phase growth of solder joint than temperature or thermomigration caused by the temperature gradient due to joule heating during current stressing. Nano indentation tests suggest that mechanical property, e.g. Young's modulus, degrades in the localized area where void nucleates during current stressing. [C2720]

"Development of a curriculum in nano and MEMS packaging and manufacturing for integrated systems to prepare next generation workforce"

In this narrative author has described background of nano and MEMS and related Microsystems packaging and manufacturing revolution and thus evolved educational framework that is essential to create desired workforce. This technology and market driven revolution is at the stem of new economy and demands training of skilled workforce to harbor and progress realization of novel and advanced products. The highlighted findings and examples are based upon author's experience in the related research and education for the past eight years at the University of Arkansas, where there is a major attention in building a nano and micro packaging and manufacturing program. [C2721]

"From Science to Start-Up — The VC Landscape for Emerging Technologies"

{no data available} [C2722]

"Preface"

{no data available} [C2723]

"Smart Polymeric Micelles as Nanocarriers for Gene and Drug Delivery"

{no data available} [C2724]

"Integrative Technology Engineering Emergent Behavior into Materials and Systems"

{no data available} [C2725]

"The Validity of Static EDL Theory as Applied to Streaming Potential of Pressure-Driven Flow in Parallel-Plate Microchannels"

A new method of testing the validity of the static EDL theory as applied to streaming potential was developed. By measuring the electrical potential downstream along the channel surface, one may determine the validity of the static EDL theory with the introduction of a flow field. Experimental results suggest that the direct applying of the static EDL theory to streaming potential measurement may cause great discrepancy which was usually to be ascribed to the surface conductance. [C2726]

"Climbing Liquid Drops on Chemically Patterned Surfaces: Potential Applications for On-Chip Microfluidics"

We employ reactive-wetting drops to move fluid against gravitational force. Early experiments have shown that the surface energy gradient must achieve a critical value in order to induce a significant increase in the front dewetting. The velocity of a climbing-drop is constant, unlike the gradual decrease intuitively linked to object under gravitation. The drop velocity does decrease, however, for increased slope. The maximum inclination, or stopping, angle for our particular setup is 25°. A non-dimensional ratio is employed to reproduce the experimentally obtained trend, and its use may be of value in the future. [C2727]

"From the Pharmacokinetics to the Intracellular Dynamic Phase — Direct Introduction of Nanoparticles into Cytoplasm of Living Cells"

We developed a technology to directly introduce nanoparticles into the cytoplasm of living cells at one time without using a micromanipulator. Moreover, we confirmed that antisense oligonucleotides as a model drug can be released slowly in cytoplasm from these particles. [C2728]

"A Novel MEMS Tunable Capacitor"

A novel MEMS tunable capacitor with a high tuning ratio is presented in this paper. The novel tunable capacitor consists of two parallel electrodes, i.e., fixed and moving electrodes and six bi-directional electrostatic actuators, which are able to produce both attractive and repulsive force to drive the moving electrode. So the novel tunable capacitor is able to move in both directions, up and down, away from its static position and therefore achieve a large tuning ratio. Numerical simulations are used to verify the working principle of the novel tunable capacitor and predict that a tuning ratio of 3:1 can be achieved at a driving voltage of 16 volts. [C2729]

"Supramolecular Design of Polyrotaxanes as Advanced Nano-Biomaterials"

{no data available} [C2730]

"Nanopillar Formation via Defect Activation and Coulomb Explosion Initiated by a 355 nm Nd:YAG Laser Beam"

The interaction of nanosecond laser pulses in the ultraviolet wavelength range with the semiconductor SiC was investigated. Under low energy fluence, an array of highly orientated nanoparticles on the surface of SiC was formed via defect activation and coulomb explosion using 355 nm UV laser irradiation. Under high energy fluence, surface modification and ablation could occur. [C2731]

"In Vitro Gene Transfection with Surface-Modified Gelatin Nanoparticles"

With the development of the two step desolvation method for the preparation of gelatin nanoparticles, it is possible to reproducibly generate homogeneous colloidal spheres. After the establishment of a surface modification to achieve stable nucleotide loading onto the particles, the goal of this study was to test this new biodegradable and simple producible non-viral gene delivery system in vitro. Two different types of gelatin nanoparticles, referring to size and zeta (ζ) potential were investigated. Therefore, we varied conditions as for example the loaded DNA amount and the conjugation media to find a preferable setup. All preparations were tested on B16F10 murine melanoma cells using pCMVLuc as reporter gene. To evaluate our results, we used commonly known, but non-biodegradable, polyethylenimine (PEI) polyplexes as "gold standard" for in vitro transfection. Additionally, we performed accompanying cell viability assays and hemolysis studies with the preparations tested to substantiate the thesis of low cell toxicity of gelatin nanoparticles. Different setups resulted in efficient gene delivery. The achieved levels of gene expression were good but lower as with optimized PEI polyplexes. Nevertheless, the already achieved results show gelatin nanoparticles as promising biodegradable alternative to existing non-viral gene delivery systems. [C2732]

"Active New Microvalve Based on Phase Change Effect"

In this work we will show a new type of a microvalve that uses the phase change effect in order to control the flow of a fluid. The valve consists just of a micro channel that possesses a heating element made of copper at one side. Furthermore, the valve can be cooled by a special external cooling system. If the fluid flowing through the channel gets a temperature below the phase transition temperature it becomes a solid. The flow of the former fluid will be stopped. By means of an electrical current applied on the heating element the flow can be restored. We have investigated in this work the flow of melted wax. The melting temperature is above 80°C. The viscosity of the wax changes from 50mPas at 80°C to 3mPas at 140°C. We investigated new microvalves with channel dimensions between 20 mm and 90 mm in diameter. Two types of the channels, with circled and elliptical shaped cross-section, have been studied, too. The wax temperature varies from 80°C to 140°C. A cooling fluid that possesses a temperature of 20°C cooled the valve. The time constant of cooling and flow stopping depends on the material of the channel, the fluid temperature and the channel geometry. It can vary between 30ms to 120ms. Technological procedures for production of such one new microvalve can be produced by means of silicon microtechnologies. [C2733]

"Molecular Imaging: A Convergence of Technologies"

{no data available} [C2734]

"Fabrications of Micro-Channel Device by Hot Emboss and Direct Bonding of PMMA"

We have fabricated and evaluated the mechanical, optical and fluidic characteristics a 50 μ m wide and a 30 μ m deep micro-channel device produced by hot emboss and direct bonding of PMMA plate with dimensions of 20mm \times 20mm \times 1mm. The fabricated micro-channel device was evaluated the bond strength, which was confirmed to be high enough for practical use as well as for quite severe cleaning conditions as ultrasonic cleaning in pure water. The optical loss around bonded interface was also evaluated and no increase in the light absorption was observed. The above results confirmed that the hot emboss and direct bonding technologies for micro-channel manufacturing using the PMMA plates realizes high performance micro channel devices. [C2735]

"Fast Prototyping of Protein Reaction Microfluidic Chips"

This paper presents an innovative approach for the prototyping of a microfluidic chip. By design modularization, unit mold batch fabrication, and mold assembly, the prototyping of polymeric microfluidic chips can be efficient and cost effective. The development of a microfluidic chip for protein reactions, including structure fabrication and chip testing for the initial and modified versions, is reported. Using the proposed approach, design modifications can be realized easily, without remaking photolithography masks or repeating the costly MEMS process. Initial results from testing two micro- fluidic chips (5cm by 1cm and 4cm by 3cm) prove the feasibility of the proposed method and show as well the potential for dramatic savings in time and cost in microfluidic chip prototyping. [C2736]

"New Biocompatible Nanoparticles Based on Fractionized Gelatin as Drug Delivery Systems for Nucleic Acids and Peptides"

{no data available} [C2737]

"Surface Oriented Self Assembled Growth of Carbon Nanotubes"

We report the self assembled surface oriented growth of single walled carbon nanotubes along the surface of [C2738]

"Nano- and biomaterials using supercritical fluids technologies"

{no data available} [C2739]

"A Biomimetic Flying Silicon Microchip: Feasibility Study"

This paper presents a feasibility analysis of developing an ultra-small biomimetic flying machine using the most advanced engineering technologies that exist today. Without regard for the cost and potential applications of such a machine, our motivation is driven entirely by a curiosity to know if it is possible to build a controllable flying machine using very leading-edge but available technologies such as MEMS, IC, and wireless technologies. Such machine would require biomimetic wings, since insects and bugs are the only ultra-small flying "machines" which offer clues as to how things should fly when governed by physical laws, i.e., aerodynamic forces that dictate how things should fly according to their characteristic length scale. We have also demonstrated in our laboratory that MEMS actuators can be made in the same scale of insect wings and "flap" at >100Hz at very low power input. This flapping frequency is well within the range of wing flapping frequency of many common insects in the millimeter dimensions. Hence, we argue in this paper that if a micro battery, simple CPU, wireless receiver, and MEMS actuators can all be fitted onto a Si chip of ~1mm² area, which weight around ~1mg, which is the typical weight of millimeter scale insects, a biomimetic flying machine can be realized. In fact, all these requirements are realizable by many advanced engineering facilities now. A flying insect robot can certainly be realized if sufficient funding is available [C2740]

"Nano devices for the future IT"

First Page of the Article [C2741]

"A novel sulfide-assisted growth of silicon nano-wires"

A large-scale SiNWs with the diameter of 20-30 nm and the length of tens of micrometers formed on silicon substrates using a novel evaporation of sulfides (sulphur and zinc sulfide) at 1080°C were synthesized; The source of SiNWs came from silicon wafers rather than silane gas as reported before. It was found that the tip of SiNWs contained sulfur, while the other positions of SiNWs did not. It is considered that the decomposition of SiS resulted in the formation of SiNWs. As referring to the oxygen-assisted growth model of SiNWs by evaporation of silicon oxide, a corresponding sulfide-assisted model was suggested. [C2742]

"Three dimensional analytical subthreshold model for non-rectangular cross-section FinFETs"

The subthreshold characteristics of FinFET's with non-rectangular fin cross-section are investigated using evanescent-mode analysis. A three-dimensional analytical subthreshold conduction model is developed by applying the superposition principle to a two-dimensional model for ideal rectangular structures. The results from the analytical model are compared to three-dimensional numerical device simulations with good agreement. The model can be used to predict fabrication technology requirement in the scaling of a realistic nano-scaled FinFETs. [C2743]

"Scaling properties of GOI MOSFETs in nano scale by full band Monte Carlo simulation"

The characteristics of both n- and p- GOI MOSFETs are simulated by 2D self-consistent full-band MC method based on quantum Boltzmann equation to evaluate the scaling behaviors between GOI and SOI MOSFETs. The simulation results indicate that both for n and p channel GOI MOSFETs have favorable scaling properties in nano-scale due to the non-stationary transport near source side especially for p channel device. But the surface roughness scattering is a critical issue that might suppress the non-stationary transport. SCE is serious in GOI devices and much thinner Ge layer has to use to optimize the performance. [C2744]

"An experimental study of NO₂ formation in the reaction of iodine with sodium nitrate in presence and in absence of tolan"

The correlation between the duration of oxidation-reduction interactions forming NO₂ in gaseous phase over the reaction mass containing I₂ and NaNO₃ acetic acid and its amount has found. The quantities of the formed NO₂ both in presence and in absence of a tolan in the reaction mass during different periods have been evaluated. The relationship between the yields of E/Z isomers and the concentration of the forming NO₂ has

been studied. [C2745]

"Thermophysical properties of maleated poly-ethylene/layered silicate nanocomposites"

Nanocomposites are a new class of composites in which the reinforcing phase dimensions are in the order of nanometer scale. In particular, the layered silicates are considered to be good candidates for the preparation of polymer-inorganic nanocomposites. The mechanical and thermal properties of polymer can be altered by adding a few vol% of nanoparticles. In this study, we focused on the effect of the nano-sized particles on thermophysical properties such as melting and crystallization, coefficient of thermal expansion, and thermal conductivity. We prepared the PEMA/layered silicate nanocomposites and the thermophysical properties were investigated by DSC, TMA, and 3ω device. The content of layered silicate was varied from 0.5 vol.% to 5 vol.%. [C2746]

"Formation of iron nano-dots by electron beam induced deposition using an ultrahigh vacuum transmission electron microscope"

First Page of the Article [C2747]

"Study on micro handling and assembly methods and tools within the project ASSEMIC"

It can be seen that during the last years there is an increasing tendency to the miniaturization towards the micro and nano devices. Those structures demand new processes, solutions and steps. The assembly procedure is a difficult task which significantly influences the final production costs and quality. The application of specially designed tools and systems for handling and assembly of micro-components is, at the moment, a must in micro system technology (MST) or micro electromechanical systems (MEMS). This paper presents the first contributions of Seibersdorf research to the research and training network "ASSEMIC: advanced methods and tools for handling and assembly in micro technology", a four years duration Marie Curie Project funded by the Sixth Framework Programme of the European Commission bringing together 14 participant institutions from 10 different countries. In this first phase of the project, Seibersdorf is mainly contributing to the parts of analysis of requirements, needed for the specification of future prototypes, as well as investigation of the state of the art in the different involved fields (micro positioning, micro handling and micro assembly). [C2748]

"Power quality monitoring system using wavelet-based neural network"

This paper presents a wavelet-based neural network technology for the detection and classification of the various types of power quality disturbances. Power quality phenomena are short-time problems and of many varieties. Particularly, the transients happen during very short durations to the nano- and microsecond. Thus, a method for detecting and classifying transient signals at the same time and in an automatic way is recommended. The proposed wavelet network (WN) combines the properties of the wavelet transform and the advantages of neural networks. Especially, the additional feature extraction to improve the recognition rate is considered. The configuration of the hardware of WN (PQ-DAS) and some case studies are described. [C2749]

"Nanoscale materials-production, properties and applications"

A well known method for the preparation of nanomaterials is the chemical reduction of metal ions, dissolved in water, with an aqueous solution of an alkali metal borohydride as the reduction agent. This method has been used to produce various compositions of nanoparticles, nanowires, nanoscale hydrogen containers, etc. The knowledge and the comparison of data for the bond strength of various diatomic molecules help us to choose proper combinations of elements in order to synthesize nano-systems with pre-requested properties. [C2750]

"Nominal PbSe nano-islands on PbTe: grown by MBE, analyzed by AFM and TEM"

Nominal PbSe nano-islands were grown in the Stranski-Krastanow mode on (111) oriented PbTe/BaF₂pseudo-substrates by molecular beam epitaxy (MBE). The morphology and number density of these islands were assessed by means of atomic force microscopy (AFM). Transmission electron microscopy (TEM) was employed to determine the strain state and crystallographic structure of these islands. On the basis of both AFM and TEM analyses, we distinguish between different groups of islands. [C2751]

"Gate bias dependent evolution due to two unintentionally formed quantum dot in a silicon-on-insulator nano-wire transistor"

First Page of the Article [C2752]

"Fabrication and characterization of nano-dots produced by electron beam induced deposition using metal carbonyls"

First Page of the Article [C2753]

"Fabrication and evaluation of thermal nano-sensor by focused-ion-beam chemical-vapor-deposition"

First Page of the Article [C2754]

"Preferential immobilization of green fluorescent protein on i nano-patterned organosilane templates"

First Page of the Article [C2755]

"Development of 'Green and Clean' Reaction Media for Inorganic and Organic Nanomaterials"

We have developed new water-in-CO₂ microemulsions under supercritical conditions of CO₂ bulk phase. Using fluorinated AOT surfactants and hydrogenated n-butanol as a cosurfactant, microemulsion solutions were obtained which could dissolve large amount of water as large as $W = 49$ at 35°C. Where W is the molar ratio of water-to-surfactant. Using varieties of surfactants and amount of cosurfactant, the composition of microemulsion has been established which gives capabilities to prepare different size nanomaterials in the range of 3 to 10 nm depending on the size of the core of microemulsion droplets. Size of the nanomaterials can be controlled with narrow size distribution by adjusting the W values of microemulsion solution. In this presentation, I shall describe the preparation of water-in-CO₂ microemulsions as a function of water content, pressure of CO₂, surfactant concentration, and amount of cosurfactant added. The new CO₂ microemulsions will replace the existing conventional media used for preparation of nanomaterials until now because of non-toxic, cheap, easily recyclable bulk phase CO₂ used in these solutions at moderately low temperature of 35°C. [C2756]

"Advanced MEMS and Integrated-Optic Components for Multifunctional Integrated Optical Micromachines"

Optical technologies can play a strategic role in improving the performance, functionality, and reducing the mass of various spacecraft technologies, such as true time-delay T/R modules for phased-array antennas and optical sensor systems for satellite navigation and systems status. However, current photonic and fiber-optic systems tend to be bulky relative to the requirements for space applications. Micro integrated-optic circuits increase the integration of optical components on a single substrate, to provide multi-function optical processing and switching similar to electronic integrated circuits. This minimizes the number of external optical interconnections required and sensitivity to external vibrations; maximizing the system information capacity, optical throughput, and reliability, while minimizing the overall system size and weight. This paper considers a systematic development of MEMS integrated-optic circuits on SOI for various space application. A unique blend of MEMS, smart-material and photonic technologies is employed to miniaturize the size of the basic components, while improving on the attainable performance. [C2757]

"The Role of Electronic Container Seal (E-Seal) with RFID Technology in the Container Security Initiatives"

After the September 11 events, both the governments and industries have illustrated the importance of transportation security as well as cargo security. The September 11 terrorists hijacked the commercial passenger aircrafts to attack to World Trade Center Towers in New York City and Pentagon Building near Washington D.C. These attacks remind the public of how transportation security establishments directly affect the national security. Today more than 85% of cargo entering the United States is coming in the standard ocean containers. It is now essential to ensure these containers are well monitored and inspected along the way as they arrive in the U.S. ports so no mass destruction materials are smuggling into this country. In the wake of the container security initiative (CSI), the Electronic Container Seal (E-Seal) and Radio Frequency Identification (RFID) technology are introduced. In this paper, the basic technical features of RFID systems are described and linked to the practical applications. This paper will also determine how the technologies perform in the real-world operational environments and evaluate the various trade-offs that exist with e-seal design and the potential impact of those trade-offs on functionality, reliability, utility, and cost. [C2758]

"Tailored Nanomaterials Systems Based on Artificial Design and Fabrication: An Overview of the

Synthetic Nanofunction Materials Project"

{no data available} [C2759]

"A Study of Passive Microfluidic Mixers"

Three designs of passive microfluidic mixers (fabricated using Micralyne Protolyne technology on a glass substrate) are studied and compared to a basic straight channel diffusion mixer. The designs are analyzed under continuous and pulsating flow conditions using numerical and experimental tools; specifically finite element analysis and particle image velocimetry. Testing and analysis are performed at pressures that can be generated using reciprocating membrane micropumps integrated into a Micro Total Analysis System. It is determined that one of the proposed mixer concepts outperforms all of the other designs considered and enhanced mixing is achieved under pulsating flow. Performance is judged based on criteria that describes the amount of mixing performed, the concentration uniformity at the outlet of the mixer, and the net flow rate. Recommendations are made on how to improve the overall performance of the passive micromixers. [C2760]

"New Functions Elaborated in Oxide Glasses by Nanotechnology"

Recent three topics of Nanotechnology Glass Project were described. (1) A proton-conducting hybrid material was fabricated using a glass plate with nano-pores. The conductivity of the hybrid glass plate was comparable to Nafion, and no corrosion or degradation observed up to 120°C. (2) Nano-particles of CdTe were synthesized in a water solution and embedded in the glass matrix using a sol-gel method. The emission quantum efficiency of 3% was attained. (3) Deep dry etching followed by overcladding buried the DOE with a deep groove inside a SiO₂ plate, which was used for fabrication of an ultra small demultiplexer. [C2761]

"NEDO Nano Coating Project: Outline and Achievements"

This project is to aim at development of advanced nano-coating processing technology through design and control of nano-coating structures with the aid of theoretical and computer techniques, since the accurate control of structures such as nano-interface, nano-pores, and nano-particles is the key to state-of-the-art coating technology. An integral part of this research is the development of fast, ultra-precise evaluation technology of the properties and performance of the coatings from the nano- to the macro-level. In this project, we have focused on an establishment of the basic technology for nanostructure control of ceramic coatings applied to metals, to provide novel functions. This technology is intended to reduce further mankind's impact on the environment and to enhance energy savings in a wide range of fields, particularly those requiring heat-resistant and corrosion-resistant materials. This project was entrusted by NEDO as "the Nanotechnology Program/the Nanostructure Coating Project" promoted by METI, Japan, and has started in 2001 and will be completed in 2006. [C2762]

"A Numerical Study of the Nozzle/Diffuser Micro-Pump"

This study numerically investigated the performance of micro Nozzle/diffuser pump subject to the influence of frequency, opening angle, and amplitude. It is found that the net flowrate of a micro-pump increased with pumping frequency and opening angle. However, a level off phenomenon of the net flowrate vs. amplitude is seen at an amplitude nearby 150-200 μm and at an opening angle above 10 degree. This phenomenon is associated with two factors that compensate with each other. One is the free jet flow from the outlet that overturns and blocks the flow from the inlet. The other is the reduction of the strength of the jet flow at a larger amplitude owing to effective increase of cross sectional area. [C2763]

"Micro Digital Sun Sensor: System in a Package"

A novel micro Digital Sun Sensor (μDSS) is under development in the frame of a micro systems technology (MST) development program (Microned) from the Dutch Ministry of Economic Affairs. Use of available micro system technologies in combination with the implementation of a dedicated solarcell for power supply and a wireless link for data communication allows TNO TPD to develop a truly autonomous and wireless sun sensor. Such a "system in a package" is small enough to be flown on a microsatellite [4]. Although several technical challenges still exist, it seems feasible to build a sensor that will be at least one order of magnitude lower in weight as compared to the current generation sensors (<30 grams) and consumes no external power. These characteristics allow it to fly this sensor on satellites that are so small that inclusion of a fine sun sensor until now has not been feasible. [C2764]

"Novel Electroplating-Based Technology for the Fabrication of Giant Micromirrors for Space and Terrestrial Applications"

A novel approach to manufacturing giant micromirrors is proposed. The approach combines selective electroplating and flip-chip based technologies. It allows for large air gaps and permits independent fabrication of the mirrors and control electronics, circumventing temperature and sacrificial layer incompatibilities between them. Design, simulation and process development for the fabrication of electrostatically actuated piston and torsion micromirrors are presented. The simulated structures are designed to allow large deflection, i.e. piston displacement of 10 μm and torsional deflection of 35°. Smooth micromirror surfaces (roughness lower than 5nm rms) and large radius of curvature (R as large as 23 cm) are achieved. [C2765]

"Design & Fabrication of Piezoresistive Six Degree of Freedom Accelerometer for Biomechanical Applications"

A miniaturized piezoresistive six-degree of freedom (6DOF) accelerometer has been developed and fabricated using bulk micromachining technology. Most accelerometers developed so far, sense accelerations in only three axial directions. This accelerometer measures three components of linear acceleration and three components of angular acceleration on three orthogonal axes in the frequency bandwidth of 300Hz. The average measured sensitivities of the fabricated sensor for linear accelerations and angular accelerations show a cross-axis sensitivity of <2%. Comparison of the obtained experimental results and finite element simulation shows good agreement. The sensor is ideal for use in biomechanical research applications such as the study of human gesture recognition systems. [C2766]

"The Concept of a 3-D Cubic Acoustical Sensor Microarray Cluster for Use in a Hearing Instrument"

The concept of a MEMS-based acoustical sensor microarray cluster that can be used in a hearing instrument to improve speech intelligibility in a noisy reverberant environment has been presented. The proposed sensor microarray cluster has a cubic geometry where five identical MEMS-based microarrays of acoustical sensors constitute each side of a cubic and the bottom of the cube has been used for mounting and interconnection purposes. The steerable beams of each individual sensor microarray are used to be synchronized and polled using a microelectronic beam synthesis engine. In this way it will be possible to provide a three dimensional dynamic directionality for the sensor microarray cluster. The system can realize an improved dynamic directional speech acquisition system comparing to planar arrays for hearing instruments. The complete cubic sensor microarray cluster can be fabricated as a single die using Standard MEMS fabrication technology. [C2767]

"Electrical Magnetization Reversal in Ferromagnetic Semiconductors"

{no data available} [C2768]

"Synthesis and Characteration of Phenolic Resin/Montmorillonite Nanocomposites"

The phenolic resin/montmorillonite nanocomposites (NCPs) were synthesized by one-step method. Then FTIR and XRD were used to characterize microstructures of samples. The results shows that phenolic has been intercalated between adjacent montmorillonite platelets and d₀₀₁ of Montmorillonite platelets increases with phenolic content increasing. The study of the thermal property also shows that phenolic resin/montmorillonite are of better thermal stability with the increase of montmorillonite content. [C2769]

"Experimental Measurements and Theoretical Estimation of Temperature in ECDM Process"

Electrochemical discharge can be effectively and economically used for machining of a wide range of conducting and non-conducting materials, ceramics, and composites. This can be also used for selective deposition of metals and micro welding. Its potentials for rapid prototyping of small metallic parts have been vindicated. All these processes require generation of temperatures above the melting temperature of the metal under consideration. In the present work, experimentally measured and theoretically estimated temperature results are presented for electro chemical discharge machining (ECDM) process. In situ temperature measurements are performed for the first time in ECDM, especially, in the machining zone with various temperature sensing schemes. The temperatures at different radii of the work piece are calculated by considering the spark as a constant, circular heat source on the surface of the work piece and considering the heat balance of each discretised element of the work piece. Experimentally measured and theoretically estimated temperature results are comparable. [C2770]

"Advanced MEMS/Smart-Material Coding and Filtering Technologies for High-Performance Miniature Integrated IR Spectrometers"

Infrared spectroscopy can be a vital component of various Earth observation and planetary exploration space

missions. It probes the characteristic vibrational modes of chemical bonds in molecules to provide information about not only the chemical composition but also the local bonding configuration and environment of the chemical bond. The IR spectral technique can be used with minimal consumables to simultaneously detect large variety of chemical and biochemical species. To date, mainly large bulk-optic Fourier Transform (FT-IR) spectrometers employing variations of the Michelson interferometer have been successfully employed in space due to the attainable performance. However, they typically require costly, large spacecraft platforms and complex environmental controls that limit the deployment of IR spectroscopy. In the following paper, we discuss the use of advanced optical coding and signal processing techniques, as facilitated using MEMS multi-channel optical signal processors, to significantly extend the performance limitations of miniature integrated-optic IR spectrometers. This technology can provide high-performance broad-band IR spectrometers suitable for passive monitoring in a compact module weighing under 2 kg. [C2771]

"Development of Inhalable Nanoparticles"

The aim of this study was to develop nanoparticles for lung delivery. Nanoparticles were incorporated into carrier particles using spray drying and a new spray-freeze drying technology. The carrier particles were manufactured with the appropriate size for pulmonary delivery. The new technology has important implications for local drug targeting and drug delivery of nanoparticle based delivery systems to the lungs. [C2772]

"A Self-Organizing Bucket Brigade"

A self-organizing "bucket brigade" or charge transportation system is studied. This system serves as a prototype of controlled dynamic self-assembly with applications to micro- and nanoelectromechanical systems (MEMS and NEMS). An experimental system is described and results of several experiments presented. Two theoretical approaches to the analysis of the system are described. A physics-based first-principles model is used to analyze the system in detail. From this, a rules-based model is abstracted from which other self-organizing transportation systems may be designed. [C2773]

"Lipid/Polymer Nanoparticles as Tools to Improve the Therapeutic Activity of Existing and Emerging Anticancer Drug Combinations"

{no data available} [C2774]

"Nano-Biodevice for Genomic Drug Discovery and Genomic Medicine"

{no data available} [C2775]

"A Monolithically Packaged Cordless Sensor System Embedding MEMS A/D Converter and Saw Transponder"

A monolithically packaged SAW (Surface Acoustic Wave) radio transponder and pressure sensor is developed for the application to a TPMS (Tire Pressure Monitoring System). The device contains the wireless transponder, which converts analog signal into digital one without any auxiliary electronic circuits and then transmits the converted data wirelessly. No power sources are needed for wireless transponder and pressure sensor. The touch-mode pressure sensor converts externally applied pressure into a capacitance, and the SAW radio transponder radiates sensor values as pulse train to the interrogation (measurement) unit. The realization of the mechanical A/D conversion is possible since the SAW radio transponder has been connected to the touch-mode capacitive pressure sensor. The SAW radio transponder and touch-mode sensor have been fabricated using a surface micromachining and a bulk micromachining technologies, respectively. The performance of the integrated, passive and wireless pressure sensor meets the design specifications such as linearity, sensitivity and noise figure. Finally, experimental results on the radio transponder and sensor without power source are presented. [C2776]

"A Novel Hydropower Harvesting Device"

Using the kinetic energy of flowing rivers directly will broaden the hydropower resources. Two designs are presented for the generation of electrical energy. Both designs are connected with a von Kármán's hydrodynamic instability. The first is a fluttering flag made of a piezoelectric polymer material, which is bending periodically in turbulent flow. Electrodes on the surface collect the generated charges. Secondly, a microstructured piezo-bimorph is presented. It is placed in an instable flow too, hence continuously bends up- and downward. Power ratings of 7.1μW per element could be achieved resulting in a power density of 70W/m³ using the common mechanical theory. Very thin films producible using micro technologies only show a completely different mechanical behaviour. The application of these film like elements could increase the power rating dramatically.

Many of those generator bimorphs together with a rectifier are built up to modules which are part of an hydropower harvesting device placed into a flowing river. [C2777]

"Anti-Retroviral Vaccine Using Polymeric Nanoparticles"

We have previously reported that concanavalin A-immobilized polystyrene nanospheres (Con A-NS) could efficiently capture HIV-1 particles and that intranasal immunization with inactivated HIV-1- capturing nanospheres (HIV-NS) induced vaginal anti-HIV-1 IgA antibody response in mice. In this study, to evaluate the protective effect of immunization, each three macaques was intranasally immunized with Con A-NS or inactivated simian/human immunodeficiency virus KU-2- capturing nanospheres (SHIV-NS) and then intravaginally challenged with a pathogenic virus, SHIV KU-2. After a series of six immunizations, vaginal anti-HIV-1 gp120 IgA and IgG antibodies were detected in all SHIV-NS-immunized macaques. After intravaginal challenge, one of the three macaques in each of the Con A-NS- and SHIV-NS-immunized groups was infected. Plasma viral RNA load of infected macaque in SHIV-NS-immunized macaques was substantially less than that in unimmunized control macaque and reached below the detectable level. Thus, SHIV-NS-immunized macaques exhibited partial protection to vaginal challenges with SHIV KU-2. [C2778]

"Power-Law Scaling Behavior in Barkhausen Avalanches of 2D Ferromagnetic Films"

{no data available} [C2779]

"Analysis of Alternative Capacitor Topologies for MEMS Switches Fabricated with Printed Circuit Technology"

New architectures to reduce the acuation voltage of a cantilever beam MEMS switch are presented. Voltage reduction is achieved through manipulation of the shape of the capacitor plates to increase the effective area and decrease the effective distance between plates. Improvements are achieved without a physical increase in footprint dimensions, beam to substrate separation, or a decrease in the spring constant of the beam. The architectures are particularly applications that require a small footprint, high degrees of electrical isolation, and low switching times. [C2780]

"Dynamic Response of a Microbeam-Supported Microplate under Interfacial Microwave Load"

An analytical model has been developed to understand the rotational dynamics of a microbeam-supported rigid microplate, which is positioned across a microchannel partially filled with an isotropic liquid. Physical phenomena included in this work are those associated with surface tension, buoyancy, hydrodynamics, interfacial microwaves, and torsional stiffness of the microbeam supports. Consideration of surface tension results in nonlinear terms for the righting moment and for the forcing function terms of the ordinary differential equation of rotational motion. Response characteristics are investigated for varying microwave amplitudes and frequencies, as well as microplate and microbeam principal dimensions. Results show that the analysis presented in this work can be used in designing microdevices for measurement of fluid properties, microwave features and pulsating pressures. [C2781]

"Design, Modeling and Testing of Polysilicon Optothermal Actuators for Power Scavenging Wireless Microrobots"

The biggest hurdle to be solved, in order to create autonomous Micro-Electro-Mechanical Systems (MEMS) microrobots, is generating power for their actuator engines. Most present actuators require orders of magnitude more power than is presently available from micropower sources. To enable smaller microrobots, this research investigated a simplified power concept that eliminates the need for on-board power supplies and control circuitry by using actuators powered wirelessly from the environment. The use of lasers to directly power micrometer scale silicon thermal actuators was explored. Optothermal actuators, intended for use on a small wirelessly propelled autonomous MEMS microrobot, were modeled, designed, fabricated and tested, using the PolyMUMPs silicon-metal chip fabrication process. A 760 μm by 710 μm prototype MEMS polysilicon-based microrobot, using optothermal actuators, was designed, fabricated and tested. Each of its parts was demonstrated to provide actuation using energy from an external laser. The optothermal actuators provided 2 μm of deflection to the microrobot drive shaft, with 60 mW of pulsed laser power. The results of these experiments demonstrated the validity of a new class of wireless polysilicon actuators for MEMS devices, which are not directly dependant on electrical power for actuation. The experiments also demonstrated a potentially viable design that could be used to propel the world's smallest autonomous MEMS microrobot. [C2782]

"Applicability of an Optimized Fiber Optic Smart Structure"

In recent years, fiber optic smart structure is widely studied because of its intrinsic benefits [1] [2]. One of the most striking evolvments is the technology, of which FBG (Fiber Bragg Grating) sensor systems are embedded in fiber reinforced composite materials, so that any ambience induced responses of the host structures can be monitored in real time, consequently proper actuations are initiated. Thus a neural system is realized. This work reports an entire optimization process of the FBG sensors embedded in Graphite/Epoxy composite material. Moreover, performance of the sensor system was observed and the applicability is discussed. Due to the mechanically orthotropic characteristics of the Graphite/Epoxy composite material, two FBG sensors were orthogonally embedded along the two principle axes in mid-plane of the specimen. When strain load was applied along one of the axes, longitudinal and shear responses of the structure were simultaneously monitored, hence its orthotropic properties were determined. Further, any randomly oriented strain applied to the specimen will be analytically quantified along the two sensors. Recurring to surface mounted resistance strain gage concept, the embedded FBG strain gage array was recalibrated, and its sensing alterability is quantified. This work tends to provide a quantitative discussion on FBG sensors' residual erroneousess after an optimized embedment, the conclusion may give designers a reference to properly interpret FBG sensors' performances, in case they are used as an embedded strain gage. [C2783]

"Microbolometer Spectrometer: Applications and Technology"

Current Thermal Infra Red (7.14 μm) multispectral imager instruments use cryogenically cooled Mercury Cadmium Telluride (MCT or HgCdTe) detectors. Now due to the increased performance of uncooled microbolometer arrays, the next generation of instruments can be designed without cryogenic cooling. TNO TPD has designed a spectrometer called the Micro Bolometer Spectrometer (MIBS), that is able to provide co-registered images in the 7 to 14 μm wavelength region with an acceptable NETD performance on the basis of currently available detectors. Apart from space based multispectral imaging, the concept can also be used for several other applications, for example, CO₂ monitoring through the broader spectral response. The removal of the standard highpass filter of the bolometer detector allows imaging in both the 3 to 5 and 7 to 14 μm atmospheric windows at the same time in a co-registered fashion. Applications include forest fire detection, military reconnaissance and, wideband flame analysis (NO_x detection in industrial ovens). [C2784]

"Nanoparticle Preparation and Its Application — A Nanotechnology Particle Project in Japan"

Nanoparticles such as metals, semiconductors and metal oxides are of great interest for a wide variety of applications in the field of information, energy, environmental and medical technologies due to their unique or improved properties determined primarily by size, composition and structure along with their self-organized film structures. In this presentation, Japan's national project on nanoparticle synthesis and its applications in nanotechnology programs is reviewed along with some new findings on synthesis technologies and the related nanoparticle-based nano-structures developed during the project. The synthesis methods include liquid phase, gas phase, liquid-based gas phase such as novel spray methods and sol-gel assisted in-situ techniques and continuous mass production method. [C2785]

"Non-Equilibrium Injection Flow in a Nanometer Capillary Channel"

Non-equilibrium molecular dynamics is applied to simulate liquid injection flow in a nanometer circular capillary. A full 12-6 Lennard-Jones potential, truncated at 2.2y, was used to govern the liquid-liquid and liquid-solid interactions. Our results show that there exists an oscillatory distribution of liquid density in the normal wall direction. The solid-liquid energy scale has a strong influence on molecular motion in the first liquid layer near the solid substrate. Under the injection condition, liquid transport in a nanometer capillary was found to behave in an unexpected wavelike motion. [C2786]

"Molecular Recognition System Controlled by Thermosensitive Complexation Using Cyclodextrin-Conjugated Poly(ϵ -lysine)s"

{no data available} [C2787]

"A New Delivery System for Double Stranded siRNA Oligonucleotides Based on Gelatin Nanoparticles"

{no data available} [C2788]

"Micro Evaporators"

The use of micro evaporation for cooling electronic components on small satellites is very promising because of its great potential on heat transferring capacity and its low mass flow. Due to the size reduction, the energy

density increases in a lot of applications in space industry. On top of this, the thermal specifications on micro devices are often more tight than in macroscopic applications. Therefore, a proper design is essential for devices to be capable of dealing with associated high heat fluxes. Using evaporation high heat fluxes can be obtained. However, a good understanding of the heat transfer and evaporation on micro scales is necessary since some physical phenomena become more (or less) important. The PhD research performed at TNO TPD (in collaboration with the Delft university of technology) leads to insight on the behaviour of two phase liquid- gas flow in micro channels. The knowledge on both the heat transfer and the two phase flow patterns can be used to formulate relationships which can be used to design micro fluidic systems. Since gravity plays a minor role on micro scales these engineering tools will be appropriate for designing space systems as well. [C2789]

"Hydrolyzable Polyrotaxanes Consisting of β -Cyclodextrins and Pluronic® for Drug Delivery"

{no data available} [C2790]

"Optimal structure of interconnection lines for GHz giga-scale nano-CMOS system-on-chip design"

As CMOS technology is scaled down to below 90 nm, interconnection lines on a complicated chip plays a key role in speed/frequency and performance. The conventional coplanar interconnection structure has good high-frequency performance, but the chip area is large. This will significantly increase chip area of a complicated system-on-chip (SOC) which require many interconnection lines. In this research, the optimal structure of interconnection lines for nano-CMOS technology with multi-layer metals is proposed and analyzed. It is found from simulation results that multi-layer non-coplanar interconnection lines with signal line at the top layer metal and ground line at a lower layer metal without planar space between lines have the optimal performance of transmission loss, frequency response, and chip area. An experimental chip is designed to verify the simulation results. The proposed new interconnection structure can be applied to nano-CMOS SOC design. [C2791]

"A learnable self-feedback ratio-memory cellular nonlinear network (SRMCNN) for associative memory applications"

A self-feedback ratio-memory cellular nonlinear network (SRMCNN) with the B template and modified Hebbian learning algorithm to learn and recognize image patterns is proposed and analyzed. In this SRMCNN, the coefficients of space-variant B templates are determined from the exemplar patterns during the learning period. The weights are the ratio of the absolute summation of its neighborhood weights in the B templates stored in the associative memory. The SRMCNN can recognize the learned patterns with distinct white-black noise and output the correct patterns. Matlab and HSPICE software have simulated the operation of the proposed SRMCNN. It is shown that the 18418 SRMCNN can successfully learn and recognize 8 incompletely noisy patterns. As compared to other learnable CNN as associative memories, the proposed SRMCNN could improve pattern learning and recognition capability. The architecture can be implemented in nano-CMOS technology for a giga-scale learning system in real-time applications. [C2792]

"On effective computation with nanodevices: a single electron tunnelling technology case study"

It is generally accepted that fundamental physical limitations will eventually inhibit further (C)MOS feature size reduction. Several emerging nano-electronic technologies with greater scaling potential, such as single electron tunneling (SET), are currently under investigation. Each of these exhibit their own switching behavior, resulting in new paradigms for logic design and computation. This paper presents a case study on SET based logic. We analyze and compare three different SET designs styles as follows. First, SET transistor based designs that mimic conventional CMOS. Second, single electron threshold logic based on the voltage threshold of SET tunnel junctions. Third, electron counting logic based on direct encoding of integers as charge combined with computation via charge transport. [C2793]

"Emerging nanoelectronics: multi-functional nanowires"

This talk aims to demonstrate that a silicon-on-insulator (SOI) nanowire technological platform could be a realistic approach to address the development of various types of multifunctional devices. Particularly, SOI nanowires could be a unique technological platform to co-fabricate: (i) nano-scaled solid-state MOS devices (such as the multi-gate MOSFETs); (ii) single-electron transistors and single electron memories; (iii) solid-state optoelectronic nano-scaled devices (modulators, optical switches, filters or even optical, interconnects for on-chip clock distribution...); and (iv) MEMS nano-resonators for full integrated RF IC functions. All these various categories of devices can take advantage of SOI intrinsic properties (technological toolset similar to silicon, natural lateral and vertical isolation, specific electrical, mechanical and optical properties) together with their aggressive scalability. Moreover, such, a technological platform could be hybridized with other nanotechnologies like molecular devices and carbon nanotubes. Some key examples, based on ongoing research projects at the

Swiss Federal Institute of Technology Lausanne and world wide state-of-the-art was presented. [C2794]

"Comparison of ventricular geometry for two real time 3D ultrasound machines with three dimensional level set"

This paper presents new results for segmentation of 3D ultrasound using a robust and smooth segmentation method based on a homogeneity-driven three dimensional level set algorithm. The segmentation was applied to echocardiographic data from healthy volunteers acquired with two 3D ultrasound machines based on matrix-phased array technology. A comparison of ventricular volumes and geometry is performed based on manual and automatic methods of segmentation. Results showed good agreement of the segmentation methods and the ultrasound machines for ventricular geometry and quantitative assessment of cardiac function. [C2795]

"Wavelet analysis of gene expression (WAGE)"

The wavelet transform (WT) is the mathematical operator of choice for the analysis of nonstationary signals. At the same time, it is also a modelling operator that may be used to impose functional constraints on data to unveil hidden groupings and relationships. In this work, we apply the WT to the chromosomal sequences of gene expression values measured with microarray technology. The application of the wavelet operator aims to uncover clusters of genes that interact by vicinity, either because of a shared regulatory mechanism or because of common susceptibility to environmental factors. Application of the method to data on the expression of human brain genes in neuro-degeneration validates the technique and, at the same time, illustrates the potential of the method. [C2796]

"High-resolution functional photoacoustic tomography"

All-optical imaging has high contrast but poor spatial resolution beyond the ballistic and quasiballistic regimes. All-ultrasonic imaging has high spatial resolution but poor contrast for early stage tumors. Photoacoustic tomography combines the high optical contrast and the high ultrasonic resolution. Our work in this emerging area of research will be summarized in this invited talk. In this technology, a diffraction-based inverse-source problem is solved in the image reconstruction, for which our group developed the rigorous reconstruction theory. We developed a prototype and accomplished noninvasive transdermal and transcranial functional imaging of small-animal brains in vivo. [C2797]

"Elastic registration of gel electrophoresis images based on landmarks and intensities"

A key technique for protein analysis is the geometric alignment of gel electrophoresis images. While in previous work either intensity-based or landmark-based approaches have been used for the registration of electrophoresis images, we here introduce a scheme incorporating both intensities and landmarks. With this approach point landmarks are localized using a model fitting scheme and this geometric information is combined with intensity information for elastic registration. By experiments on the basis of images of different levels of complexity we demonstrate that intensity information alone is generally not sufficient for accurate registration. However, it turns out that the incorporation of landmarks significantly improves the registration accuracy. [C2798]

"Laser cleaning technology for micro and nano device applications"

In micro and nano device fabrication technology, local material removal is one of the basic operations for structure formation. This technology involves different materials in form of thin films. The materials of the greatest interest are: photo resist and different metals (aluminum, gold, copper, titanium). Classical methods for structure formation on the surface of a silicon wafer are based mainly on chemical processing, starting with photo etching, chemical etching, and chemical-mechanical linearization. In order to propose new methods of higher quality from the point of view of environment protection and also from the point of view of the processing quality we have studied the possibility of thin films controlled removal under the action of laser radiation. As a laser source we have used an excimer laser, with the wavelength of 248 nm and pulse duration 30 ns. Materials tested in our experiments for laser removal were: photoresist, thickness 0.2-12 μm ; metals (gold, aluminum, copper and titanium). Substrate material was silicon wafer with a mirror quality surface. [C2799]

"Simulation of three-dimensional copper-low-k interconnections with different shapes"

Interconnect plays a central for nanodevice, very large scale integration (VLSI), and system-on-a-chip (SoC). Investigation of interconnections will significantly benefit both the device fabrication technology and the VLSI SoC design communities (X. Wang et al., 2003). Copper (Cu) has recently become a promising and popular material for the fabrication of interconnections. Unlike aluminum (Al) interconnects, the geometry of fabricated copper interconnects could be changed and deviated from the original structures. We in this work computationally

explore the geometry effects on the parasitic elements of interconnect, resistance (R), capacitance (C), and time constant for RC delay (X. Wang et al., 2003 and Y. W. Liu et al., 2000). For a given technology node, the geometry is explored with respect to a minimization of RC time delay. Optimal Cu-low-k interconnect is significant and necessary for SoC era. It also benefits high frequency applications. [C2800]

"2004 10th International Workshop on Computational Electronics (IEEE Cat. No.04EX915)"

{no data available} [C2801]

"The present and the future of nanoelectronics"

This paper discusses further possibilities and challenges of nanoelectronic devices and possible applications where most likely revolutionary "nano" would fit in our future electronic systems. [C2802]

"A case study of a microsystems MSc curriculum"

This paper tries to define the contents of master's programmes in Nanotechnology or Nanoengineering. This emerging technology holds large promises for industrial innovation and we need to prepare graduates properly as they will be confronted for most of their future careers with these new developments. The nano-world is a multidisciplinary world and the shortest way to a bad curriculum is filling it with a conglomerate of subjects from all disciplines. We should look for a philosophy and try to integrate disciplinary knowledge. Some of these questions are discussed and an implementation for a master's programme under the umbrella of Electrical Engineering is presented. [C2803]

"A fiber-optic powered wireless sensor module made on elastomeric substrate for wearable sensors"

We demonstrate an integrated sensor module that combines a photonic nano-porous sensor and a bias-free optical powered RF transducer. The sensor signal is encoded in the RF frequency ready for transmission. The entire sensor module does not include battery and is constructed with the flexible and biocompatible elastomeric polymer, PDMS. This technology holds promise for wearable sensors. [C2804]

"A bone-material-based sensor"

Bones are now considered as a well accepted series of piezoelectric materials. Several researchers have used the bone material to develop piezoelectric sensors for the measurement of pressure, force, acceleration and other such parameters. However, with the advancement of technology in sensor systems, micro and nano-scale devices are now being developed by using semiconductor or biological materials, all over the world. Bio-chips based on DNA, and bio-MEMS, etc are some of the examples. In the present research, new bone chips have been developed for various sensor applications, mainly micro or nanoscale systems. Design and fabrication aspects of the bone sensor chips for nano-transducers are discussed in detail here. Possible biomedical applications of these chips are also given in brief. [C2805]

"Electron transport through complex ultra-thin wired networks"

We have made the first attempt at investigating electron transmission through a network involving complex loops. When two Aharonov-Bohm rings are brought together to form a complex network, the anti-bonding picture allows the electron to circulate only on the small loop and the bonding picture allows the electron to circulate on the large combined loop. When an electron spreads a part of the wave in the bonding picture and a part of the wave in the anti-bonding picture, the splitting of the wave causes the electron to behave like a "fractional" charge. Similar to the fractional Hall effect, this fractional charge is manifested in the flux periodicity from the two applied fluxes in the loops and is thus experimentally observable. The transmission behavior through reducible and irreducible double Aharonov-Bohm loops is presented. The applications of this new electron-wave computing method by a quantum resistor network is a possible new direction for future computing technology [C2806]

"Novel micro gripping, probing, and sensing devices for single-cell surgery"

Several novel devices under development in our laboratories to ultimately realize a micro robotic system for single cell nanoscale probing, injection, imaging and surgery is described in this paper. Thus far, we have 1) developed MEMS polymer grippers that can be actuated under water with very large deflection and are capable of gripping 500µm embryonic cells in water with 2 V input; 2) developed a probe-etching technique to controllably shape fiber probes into various tip geometries, i.e., fibers with initial diameter of 125 µm were sharpened into tips with angles ranging from [C2807]

"Nano-particle reinforced solders for fine pitch applications"

In the present study, the influence of nanopowders such as Ni, Cu and Mo on the phase formation, microstructural characteristics, and mechanical behaviour of conventional solder alloys (63Sn/37Pb and Sn/3.8Ag/0.7Cu) has been investigated. The composite solders were prepared by mechanical mixing of nickel (Ni), copper (Cu), and molybdenum (Mo) nano powders with solder alloys followed by cold compaction and sintering. The sintered composite solder alloys were characterized by using SEM and EDX to identify the phase formation and morphological features. The addition of metallic nanopowders such as Ni, Cu, and Mo are observed to influence the grain size and interfacial reaction kinetics of solder alloys. The mechanical properties of the composite solders were measured to study the effect of nanoparticles on the deformation mechanisms.

[C2808]

"Bed of nails-100 microns pitch wafer level interconnections process"

The rapid advances in IC design and fabrication continue to challenge the electronic packaging technology, in terms of fine pitch, high performance, low cost and better reliability. In the near future, the demands for higher I/O count per integrated circuit (IC) chip increases as the shift towards the nano ICs with feature size less than 90nm. To meet the above requirements, the chip-to-substrate interconnection technologies with less than 100µm pitch are required. Currently, the CTE mismatch between Si chip and substrate and assembly yield of such fine pitch interconnections serves as the biggest bottle neck issue. In this work a simple copper column based bed of nails-wafer level interconnects showing greater potentials in meeting some of these requirements for next-generation packaging is reported. The process development of fabricating the copper columns with various height and solder deposition on to the tip of the column is reported. This technology has been developed to meet fine pitch of 100 microns and high density interconnections. The development of a test chip demonstrator of 10 Ч 10mm² with 3338 I/Os designed and fabricated for optimizing the process and the board level reliability test with out underfill performed under temperature cycling at range of -40°C to 100°C are also presented. [C2809]

"Assembly and reliability of flip chips with a nano-filled wafer level underfill"

The assembly and packaging of electronic devices today is becoming increasingly challenging and demanding because of requirements for smaller, faster and lighter products that provide increasing functionality at low cost. These requirements continue to place greater demands on the electronics industry and mandate improved packaging technology. In part, flip chip packaging technology is the response to these demands and provides a solution to these challenges. While flip chip packaging provides a solution to evolving device requirements, underfill materials are required to improve flip chip device reliability. These resins overcome poor device reliability issues resulting from the mismatch of coefficient of thermal expansion (CTE) between the silicon die and the organic substrate. However, offsetting the gains in device reliability are additional processing steps that adversely affect manufacturing productivity. To compensate for this adverse effect on manufacturing productivity, several new processes, such as wafer level underfill, have been developed. In this paper, we describe the assembly and reliability of flip chips with a nanofilled wafer level underfill (WLU). This approach allows application of the underfill material on the entire wafer, such that many chips can be underfilled simultaneously. Assembly is then carried out with a compatible epoxy flux material. Air-to-air thermal shock (AATS) results and failure mechanisms are described for this novel approach [C2810]

"A study on the mechanical behavior of the sputtered nickel thin films for UBM applications"

Nickel films of different thicknesses of 0.5 and 0.8 µm were deposited by DC magnetron sputtering on the adhesion promoting Ta layer deposited on the silicon (100) wafer. The sputtering conditions used were 4 Ч 10⁻⁶ base pressure; 3 Ч 10⁻¹ working pressure; 4 kW sputter power for 8 inch targets. The films were annealed in vacuum at temperature 200°C and their elastic modulus and hardness were measured by nanoindentation technique (hysitron triboscope). Different load rates were used when indenting the samples. The influence of thickness and annealing temperature on the mechanical behaviour of nickel thin films is explored in the present work. [C2811]

"Effects of wetting angle and loading direction on fatigue behavior of multi-copper column flip-chip interconnects"

This paper describes a study of solder joint shape evolution and its effects on the fatigue behavior of multi-copper-column flip-chip interconnects. Surface evolver has been used for the solder joint prediction in terms of different solder-copper wetting angles and the number of copper column per interconnect. A systematic procedure has been developed to integrate the solder shape prediction with the stress/strain analysis of the interconnects, in which the solder surface geometry is first predicted and optimized by surface evolver, and then

the key points and surfaces of the solder model are exported into ANSYS where the stress/strain behavior of the interconnect is investigated. A cyclic in-plane displacement loading is employed to simulate the interconnect deformation due to the thermal mismatch of chip and substrate. The effect of loading direction and solder-copper wetting angle on the plastic strain range within a single loading cycle was studied. It is found that for each multi-column interconnect, there exists an optimum orientation of the columns with respect to the package which would give the highest fatigue life [C2812]

"On achieving large inductances for small on-chip inductors through providing pre-programmed multi-dipole cushioning for the spiral inductors via nano technology"

The verified success of proton bombardment treatment in both the device isolation and the inductor Q-improvement (C. P. Liao et al., 2003) (C. P. Liao et al., 1998) on already-manufactured mixed-mode IC wafers (prior to packaging) has also uncovered new phenomena, especially the explosive rises of inductance near certain frequency (or, frequencies) (C. P. Liao et al., 2003). A previously proposed theory identified the cause to be resonant interaction between the inductor EM wave and the proton-caused defect electric dipoles (C. P. Liao et al., 2003). Based on such understanding, this paper aims at providing a new possibility of greatly enhancing the effectiveness of on-chip inductors by cushioning them on multiple dipoles using nanotechnical means [C2813]

"A numerical study of fatigue life of copper column interconnections in wafer level packages"

A copper column (CuC) interconnect technology is proposed in the nano wafer level packaging program as a chip-to-substrate interconnect solution for 20 mm by 20 mm package with 100 μm pitch. Currently thermo-mechanical reliability of solder joint continues to be a major concern due to the CTE (coefficient of thermal expansion) mismatch between chip and substrate. A FEA (finite element analysis) is carried out to estimate the fatigue life of the (critical) outermost corner CuC interconnect under thermal cycling. The commercial FEA software ABAQUS is used. Since a 3D finite element model constructed using 3D solid elements requires prohibitive computational resources, a macro-micro modeling approach which is feasible for handling simulation of large packages is used. This modified approach uses a global shell-and-beam model. By using shell-to-solid submodeling technique, a finely meshed submodel of the critical CuC interconnect can be analyzed. Maximum inelastic shear strain range is then extracted to estimate the solder joint fatigue life based on Solomon's correlation. In the current study, three CuCs with different heights are investigated. Fatigue lives of those three CuC interconnect are estimated and failure sites identified. [C2814]

"Ultra fine-pitch wafer level packaging with reworkable composite nano-interconnects"

The decrease in feature sizes of micro-electronic devices has underlined the need for higher number of I/O's in order to increase its functionality. This has spurred a great interest in developing electronic packages with fine and ultra fine pitches (20-100 microns). Most of the compliant interconnects that are currently being developed have inductance and resistance higher than desirable. This work presents a novel low-temperature fabrication process that combines polymer structures with electroless copper plating to create low stress MEMS structures for extremely fine pitch wafer level packages. Finite element analysis of these structures shows tremendous reduction in the stresses at the interfaces and superior reliability as IC-package nano interconnects. Low CTE polyimide structures with ultra-low stress, high toughness and strength were fabricated using plasma etching. This dry etching process was tuned to yield a wall angle above 80 degrees. The etching process also leads to roughened sidewalls for selective electroless copper plating on the sidewalls of polymer structures. Metal-coated polymer structures from MEMS fabrication techniques can provide low-cost high-performance solutions for wafer-level-packaging. This work also describes a material solution synthesis route to develop reworkable nano-dimensional interfaces for IC-package bonding. Reworkability is addressed by a thin (200 nm) interface of lead-free high-strength solders using selective electroless plating. Lead-free alloy films were deposited from aqueous plating solutions consisting of suitable metal salts and reducing agents at 45°C. The lead-free solder composition was controlled by altering the plating bath formulation and was characterized using SEM, XRD and XPS. Solder film formed from the above approach was demonstrated to bond the metal-coated polymer interconnects with the copper pads on the substrate. [C2815]

"Techniques for nano-scale deformation measurement"

Deformation measurement of mechanical-electrical devices is important for their reliability evaluation. However, with the development of fabrication technology, sizes of mechanical-electrical devices are reduced to micro or even nano-scale. Correspondingly, testing resolution of the required metrology techniques must be improved to the same or even higher level. The commonly used characterization facility with nano-scale resolution is STM/AFM/SEM etc. In this paper, some metrology technologies based on these facilities for nano-scale

deformation measurement, e.g. AFM/SEM moire and AFM/SEM digital speckle correlation are introduced, including their principles, advantages and disadvantages. Their applications in the deformation/strain measurement of MEMS and IC packages are highlighted. [C2816]

"Phase-correlated dynamic CT"

Phase correlated CT is the measurement of an organ that exhibits quasi periodic motion. Dedicated image reconstruction algorithms utilize only those data ranges that have been acquired within the desired motion phase and achieve to produce motion free image data. Dynamic CT means covering an organ of interest multiple times to monitor the concentration of contrast agents over the time. Thus information about blood flow or perfusion is obtained. Phase correlated dynamic CT is the combination of both methods. However it requires to simultaneously measure complete organs during a duration that covers several motion cycles. Although this is far from optimal with today's CT technology we have performed dynamic CT scans of the heart with a 4 slice scanner. In this paper we discuss the application and reconstruction algorithms under the assumption that true cone beam medical CT scanners with 64 slices or more (as they have been announced for 2004) are available. [C2817]

"Ultra-fast 3D filtered backprojection on commodity graphics hardware"

Recent efforts in cone-beam scanner technology have focused on developing interactive scanning capabilities, for example, to enable image-guided surgical interventions or real-time diagnosis with time-varying data. However, apart from a fast scanner these applications also require a fast reconstruction algorithm to match. The filtered backprojection algorithm devised by Feldkamp, Davis, and Kress is the most widely used algorithm for 3D reconstruction from cone-beam projections, and it is the algorithm with the lowest complexity. Yet, pure software implementations have difficulties to process the data at the speeds required for real-time scanning. One option is to utilize expensive and rare custom boards for this purpose. We describe an alternative solution, which is inexpensive, uses readily available PC graphics hardware boards, and provides the desired performance at the quality required. [C2818]

"3-D multispectral monitoring of living cell signaling using confocal imaging and FPGA processing"

Online control of living cell signal propagation experiments is being facilitated with field programmable gate array (FPGA) processing. The technology approach captures confocal fluorescence microscopy imagery in a manner that real-time, live-cell chemical signaling can be monitored during an experiment for extended time periods. The experiments obtain quantitative, spatial characteristics of the cell chemistry from the imagery through analysis, following a localized perturbation stimulus. The construction of a high-speed, confocal microscope provides simultaneous, two color image acquisition, at speeds of up to 30 fps, allowing near-real-time fluorescent resonance energy transfer and subsequent ratiometric, chemical signaling analysis. The FPGA provides real-time image processing hardware for observing adjustments of the microscope settings as the images are received, using real-time image registration and fusion algorithms displayed through a user interface. [C2819]

"Software process: the key to developing robust, reusable and maintainable open-source software"

The practice of image processing inherently requires software development. Creating this technology requires designing, implementing, debugging and testing software applications on a continual basis. Furthermore current software development is typically performed in a distributed environment involving many developers. While the use of open-source software may create collaborative communities that enhance overall technology exchange, it does nothing directly to manage change nor does it address the quality of the underlying software. This paper describes a software development process that has proven vital to the success of the widely used open-source toolkits ITK (itk.org) and VTK (vtk.org). This process facilitates cross-platform development, includes automatic documentation generation, integrates continuous testing, and posts the results of the process on publicly accessible Web pages. The net result is that a responsive feedback loop is created between the developers in the community and automated processes to measure software quality. With this process software converges towards better software as long as the process is enforced. The tools described here are open-source and available for use in academic and commercial applications. [C2820]

"Image segmentation with the combination of the PCA- and ICA-based modes of shape variation"

How to constrain the deformations in deformable model-based image segmentation is a well-studied issue. Many methods that use the modes of shape variation generated from a training set shapes have been introduced. Most of these methods rely on principle component analysis (PCA) to statistically model the variability in the training set. Independent component analysis (ICA) has been proposed for this purpose, too. In this paper, we combine the PCA- and ICA-based modes of shape variation using a consecutive approach: an a priori model

is deformed first by the PCA modes, which represent the global shape variability in the training set, and then, by the ICA modes, which have a more local character. The method is validated using a set of three-dimensional (3D) brain MR images. The results prove that by applying the ICA modes after the PCA modes the accuracy of image segmentation is statistically significantly (p [C2821]

"Toward leukocyte recognition using morphometry, texture and color"

Although blood cell morphological analysis has been progressively replaced by new technologies, it is often possible and necessary to diagnose some types of leukemia by visual inspection. In order to automate this process, pattern recognition methods are used in the present work for computer-aided diagnosis, considering a variety of morphometric features, expressing size and shape, color and texture, which are combined in order to achieve more accurate results. The large number of measurements implies selection methods to be applied to the identification of the most discriminative subset. This paper describes 62 cell morphological attributes extracted, selected and analyzed using a system under development. We validate our results by using the Weka (Waikato environment knowledge analysis) machine learning algorithms. The obtained results illustrate the importance of feature selection for improving the classification of leukocytes from blood smears. [C2822]

"Atomic layer deposition for fabricating capacitive micromachined ultrasonic transducers: initial characterization"

In this paper, we examine the utility of a new method for fabricating capacitive micromachined ultrasonic transducers (CMUTs). The method is based on atomic layer deposition (ALD) technology, which uses a self-limiting binary reaction process to produce ultra-thin membranes. Advantages of ALD include precise control of dimensions including gap-width between the capacitor plates, membrane thickness and radius, lower cost due to a reduction in the number of fabrication steps, the potential to use a large variety of materials, and increased reliability due to the enhanced surface quality of the membranes. These capabilities promise fabrication of transducers with superior operating characteristics. However, no study has yet documented sensitivity and power requirements for CMUTs created using ALD. We present here a first-order mechanical and equivalent circuit analysis along with a fabrication process to create and characterize CMUTs using ALD. Results show that these systems have the potential for excellent sensitivity and decreased power requirements. Work to test the fabricated elements is currently underway. [C2823]

"Method for assessing augmented reality needle guidance using a virtual biopsy task"

The Sonic Flashlight is a device that permits real-time in situ visualization of ultrasound images by reflecting calibrated images displayed on a flat-panel monitor from a partially transparent half silvered mirror. This system presents the illusion that the ultrasound slice is "floating" within the patient's body, and we believe it will be a useful visualization technique during ultrasound guided interventional procedures. While our preliminary research indicates that the Sonic Flashlight is practical in a clinical setting, we lack empirical data that demonstrate our hypothesized improvement in needle placement accuracy. To this end, we have designed a system that presents "virtual phantoms" to the operator by tracking a non-scanning Sonic Flashlight and a mock needle with a miniBird™ (Ascension Technology) magnetic tracking device. This system allows us to present the correct slice through a stored image volume and compute the error in position between the needle tip and the center of the virtual target. Preliminary data suggest that our device is capable of acquiring data that is consistent with the physical movement observed during the test and is qualitatively similar to data acquired in an earlier analysis of surgical tool movement. While it is not yet possible to draw definitive conclusions about the impact of the Sonic Flashlight on needle guidance, these data suggest that such a study will be possible using the virtual phantom system that we have developed. [C2824]

"Indoor hybrid infrared-radio access network"

A novel hybrid infrared-radio access network for indoor nano-cells is introduced, in which radio is used as a back-up if the infrared propagation path is inoperable due to incomplete coverage or shadowing. The proposed system is originated from the radio over fiber concept, associated with arrayed waveguide gratings (AWG) and subcarrier multiplexing (SCM) technologies, and capable of serving multiple users simultaneously with multi-services. A model is designed for the proposed hybrid infrared-radio access network, using the VPI software package to investigate the physical layer issues, with emphasis on modulation schemes. Physical characteristics of infrared channels using intensity modulation with direct detection (IM/DD) are presented. The performance of a hybrid infrared-radio AWG-SCM access network with 4 subcarrier frequencies, 2.4, 5, 17 and 24 GHz, using different modulation schemes is discussed in detail. [C2825]

"Observation of single electron tunneling effect in silicon-rich oxide"

The transport properties of Al/SRO/Si MOS-like structures were studied. A staircase behavior in the current versus voltage curves was observed at room temperature. This staircase behavior is ascribed to the Columbic blockade effect in the Si nano-dots embedded in the silicon oxide. The structure can be equivalent to a 2D multi-tunneling junction array, where the dispersion of the parameters such as dot size, distance and tunnel resistance produce the dispersion in the stair voltage. The ultra small dot size is the main reason to observe the Columbic blockade effect in this structure at room temperature. [C2826]

"Large scale assembly of carbon nanotube-based integrated circuit structures via "surface-programmed assembly" method"

We present a high-precision mass production method for single walled carbon nanotube (SWCNT)-based circuits. In this strategy named "surface-programmed assembly", SWCNTs from the suspension are attracted toward molecular patterns on the substrate and assemble onto specific locations with precise orientations. Significantly, since the method does not rely on any external forces or slow serial patterning techniques, it can be done in a completely parallel manner and is suitable for high-throughput applications. We assembled millions of individual SWCNTs and SWCNT-based circuit structures over 1 cm² size sample surface in a matter of minutes with a high yield. [C2827]

"Processes in bulk nano-TiB₂-Cu composites under electric erosion"

TiB₂-Cu nanocomposite materials were found to exhibit essentially new path of degradation under electric erosion. Porous TiB₂-enriched layer was formed on the surface and no copper melt was observed to squeeze out. Weight losses of nanocomposite material were 10 times lower compared to pure copper and arc spot size was about an order of magnitude increased. It is assumed that this particular behavior is caused by the high content of nanoparticulate inclusions and increased number of electron emission centers in nanocomposite material. [C2828]

"The prospect on semiconductor memory in nano era"

For the prospects on future semiconductor memory, the key technical limits of future technology scaling in conventional memories and the directions to overcome the problems are reviewed. In addition, we reviewed the technical challenges and opportunities of emerging new memories such as FRAM (ferroelectric RAM), MRAM (magnetic RAM) and PRAM (phase-change RAM) which has been recently focused as candidates for idea memory which can solve the problems of conventional memories. [C2829]

"Atomic layer deposition: a film technology for the nano device era"

Atomic layer deposition (ALD) is emerging as an enabling thin film deposition technology for making semiconductor devices below 100nm design rules and for thin film head sensors (data storage) above 40GB/in². This paper reviews the historical context of ALD as well as important critical ALD applications. Dielectrics for high topology DRAM capacitors, advanced high-k gate and barriers for interconnect use are discussed. Finally, recent enhanced ALD deposition rate pathways are reviewed. [C2830]

"Abnormal off-state leakage current increasing with reduced silicon body thickness in nano-SOI devices"

A novel phenomenon is revealed in this paper, i.e. when the channel doping concentration is heavy, the off-state current doesn't show the continuous decreasing trend with the decrease of silicon body thickness as most literatures reported. Detailed explanation was presented. Therefore, as far as LOP applications are concerned, in comparison with UTB MOSFET slightly higher channel doping and much thicker silicon body thickness can be considered as a better choice for device design. [C2831]

"Electron beam lithography and its application in fabricating nano-device"

The nano-fabrications are playing an ever-increasing role in science and technology research. The electron beam lithography is the key technology to realize nano-fabrication. Electron beam lithography and structure of e-beam system are introduced in this paper. Some key technology such as the proximity effect correction, resist process, and mix & match lithography are investigated. The 0.1 μm GaAs PHEMT devices and 36nm CMOS device are successfully achieved by combining the above technology. [C2832]

"Particle innovations in copper CMP slurry development-impact of hydrophilicity, hardness, and functionality"

Surface planarity is of paramount importance in fabricating advanced semiconductor devices at wafer level with minimum feature size smaller than 0.25 μm . Chemical mechanical polishing (CMP) is the most viable approach and has become an enabling technology to address the planarity issues. With the integration of copper as interconnect and low k materials as dielectric, the CMP community is facing an ever increasing demand on reducing defectivity without sacrificing production throughput (Kawahashi and Hattori, 2001). Key issues in CMP today include reduction of surface defectivity and enhancement of planarization efficiency. More specifically, the polished surface should be free of defects such as scratches, pits, corrosion spots, and residue particles (Kondo et al., 2000). To accomplish these goals, we have investigated a wide range of pathways including the use of unique abrasives with varying degree of hardness, hydrophilicity, and functionality such as nano diamond, plate like boron nitride, functionalized silica, encapsulating vesicles, and micelles. In this presentation, some fundamental aspects of the CMP process were given first. Several academic and industrial examples were used to illustrate the issues and challenges during the implementation of various slurry designs into the CMP processes. [C2833]

"Meeting Si challenges: nano technology development in China"

Leading edge technologies are essential to the foundry success in mainland China. In this paper, 90 nm and beyond technology with 1.2 nm physical gate oxide, strained silicon, NiSi and low-k Cu interconnection for high performance logic is presented. A highly manufacturable technique for improving transistor performance is reported. [C2834]

"An analytical charge density model comprising 1D quantum mechanical (QM) effect for sub-100nm bulk silicon MOSFETs"

An analytical charge density model considering 1D quantum mechanical (QM) effect perpendicular to the channel, which has substantial impact on the characteristics of sub-100nm bulk silicon MOSFETs is developed. The model yields excellent accuracy compared to numerical simulations in both sub-threshold region and strong inversion region, in a large range of channel doping and oxide thickness. Therefore, it is promising to develop a more accurate I-V and C-V model for nano-scale MOSFETs, especially in sub-threshold region. [C2835]

"Metal nano-dot memory for high-density non-volatile memory application"

New nonvolatile memory with extremely high density metal nanodots, MND (metal nanodot) memory, is proposed for a future high density nonvolatile memory application (Takata et al., 2003). Fundamental characteristics of the MND memory were evaluated. MND film is used as a charge retention layer in the MND memory. The MND film consists of the thin oxide film that dispersively includes high density metal dots with nanoscale. The MND film is formed by using sputtering technique with a special sputtering target. The diameter and the density of the MND in the film are typically 2-3 nm and around $2 \times 10^{13}/\text{cm}^2$, respectively, which were superior to that of Si nanodot memory. Nonvolatile memory operation at a relatively low voltage and good endurance characteristic were confirmed in the MND memory fabricated according to the conventional MOS process. [C2836]

"Computational investigation of velocity overshoot effects in double gate MOSFETs"

The velocity overshoot effect has been simulated in nano-scale double gate MOSFETs and compared by different simulation method including hydrodynamic model (HD model) and Monte Carlo method (MC method). As we know, the hydrodynamic model tends to overestimate the velocity overshoot, so how much the overestimate of HD model can reach to, and how this overestimate can impair the simulation accuracy of the final device characteristics, is investigated. Based on the simulation results, the quantitative study of the velocity overshoot effect and its related error on the performance of DG MOSFETs are obtained. [C2837]

"Quantum effect simulation of SOI MOSFETs considering impact ionization"

A robust quantum effect device simulator with density gradient model is developed. Characteristics of nanometer scale SOI MOSFETs are simulated including quantum effect and impact ionization for the first time. In extremely small SOI MOSFETs the impact ionization is suppressed. [C2838]

"Integrated circuit based biosensor technologies for DNA-microarray applications"

The paper describes the development of a DNA-microarray using a standard integrated circuit (IC) fabrication process. Unlike conventional electronic systems, biochips have to handle molecular solutions that are uncommon in conventional IC technology. In addition, incompatibility between biological processing and electronic signal transduction requires special considerations to find detection protocols that are acceptable for both systems. The

work presented utilizes a CMOS compatible process to fabricate a biochip for DNA identification in an array format. A self-assembled nano-metallic particles detection protocol is developed for direct conductivity measurements. The features provided by this technology include: (1) process compatibility with standard CMOS process; (2) highly selective immobilization of DNA probes in confined areas; (3) background signal reduction; (4) increased dynamic range by conductive enhancement. [C2839]

"Novel gas sensor based on nano-zeolite films for the nerve agent simulant dimethylmethylphosphonate detection"

A novel gas sensor based on nanosized zeolite for the detection of nerve agent simulant gas dimethylmethylphosphonate (DMMP) is developed. Novel sensing membrane materials of nanosized zeolite films of ZSM-5 and of Ag+modified ZSM-5 are immobilized on a QCM (quartz crystal microbalance) piezoelectric sensor device. A frequency shift with different concentrations of DMMP is measured. The gas sensor based on nanosized zeolite in resonating mode, whose resonant frequency shifts due to mass loading, has shown high sensitivity for detecting DMMP. The minimum detectable concentration of DMMP is 1 ppm in N₂ at 303 K. The frequency shift is about 60 Hz for 1 ppm DMMP. In order to improve the selectivity of the sensor to DMMP from other organic gases, different pore sized films, such as ZSM-5 zeolites and Ag+modified ZSM-5 zeolites, are studied. The frequency shifts for two other organic gases, such as acetone and ethanol, at 1 ppm concentration are observed for the sensor selectivity detection. The relationship between frequency shift and temperature for 1 ppm DMMP has been studied. The best adsorption temperature is 303 K and the desorption temperature is at the DMMP boiling point, 473 K. Using principle component analysis (PCA); we can easily qualify and quantify the DMMP gas. [C2840]

"Nano-structured multi-layer SiGe alloy grown by ultra high vacuum chemical vapor deposition"

High quality single-layer and multilayer nanostructured Si_{1-x}Ge_x have been successfully grown on Si(100) substrates at low temperature by ultra-high vacuum chemical vapor deposition (UHV/CVD). The UHV/CVD system integrated three chambers into a whole and the growth chamber base pressure of 5.0 × 10⁻⁸ Pa can be available. The nanostructures of SiGe/Si were characterized using high-resolution X-ray diffraction (HRXRD) and cross-sectional transmission electron microscopy (XTEM). The results show good crystal quality and sharp interfaces. This demonstrates further crystal quality improvements of nanostructured SiGe alloy may be available in the application of microelectronics and optoelectronics. [C2841]

"Nanofabrication from MEMS technology"

In this paper is reviewed a novel nanofabrication method that has been developed from the traditional MEMS technology with anisotropic etching, deep reaction ion etching and sacrificial layer processes. With such a new technology, nano needles, nano wires, nano beams, even nano devices, can be fabricated in a batch process. Beams with thickness of 12 nm, a nano tip with a heater on the beam, and a nano wire the width and thickness of which is only 50 nm, are demonstrated. The scale effect of the Young's modulus of silicon has been observed and nano-electronic-mechanical data storage has been achieved. [C2842]

"Nanoelectronics-now or never?"

Traditional 'top-down' microelectronics has become nanoelectronics with device dimensions comparable to those being explored in the new field of 'bottom-up' nano- and molecular electronics. We use the terms, top-down and bottom-up, in a very general sense. Top-down refers to a way of thinking and building that begins at the macro (continuum) scale and pushes to the nanoscale. Bottom-up refers to a way of thinking and building that begins at the atomistic level and builds up to the nanoscale. The top-down approach has already delivered silicon MOSFETs with channel lengths of 5 nm, but scaling down device dimensions with commensurate increase in device and system performance is increasingly challenging. Bottom-up technology has demonstrated molecular switches, nanotube and nanowire FET's, NDR and single electron devices, and ultra-dense memory prototypes. Is bottom-up nanotechnology ready to address the industry's challenges, or is it still long-term research with essentially unpredictable outcomes? This panel debates the question of what the intersection of top-down and bottom-up electronics mean to semiconductor technology of the future. A panel of experts provide their perspectives and engage the audience in a debate on the likely role of unconventional nano- and molecular electronics in future electronic systems. [C2843]

"Session 21-Emerging Technologies Nano-Computing Devices"

{no data available} [C2844]

"Transfer matrix approach to study light scattering in complex layered media"

Many useful and interesting optical applications of thin films make use of multilayer stacks of films, or layered media. To evaporate multiple layers while maintaining control over both refractive index and individual layer thickness has become a matured technology today. In recent years, light scattering with nano-structures has received much attention due to the advancement of modern crystal-growth techniques such as MBE and CVD. In nano-scales, in which quantum mechanical principles play an essential role, material properties are different from that we observe in macroscopic world. Due to the size effect, the optical constants of nano-structures become much more complex than that of bulk material. In this work, light scattering in complex layered media is investigated. A transfer matrix approach is employed to discretize the dielectric function profile of the complex layered media and the transmission coefficient is calculated by matching the boundary conditions at each interface. The polarization effects and geometry-dependent characteristics are considered in our simulation model. The formulation and program are tested by comparing with some standard examples in the textbooks as limiting cases, $\epsilon(z)$ and $\mu(z)$ can be arbitrary complex functions in our calculations. Photonic band gaps (PBGs) have been studied. PBGs are affected seriously by the complexity of materials and the polarization. Field enhancement along with ATR is investigated. Left-handed materials are also considered. Detailed analysis is presented. [C2845]

"High performance and high reliability polysilicon thin-film transistors with multiple nano-wire channels"

We have investigated the lightly-doped drain (LDD) polysilicon thin-film transistors (poly-Si TFTs) with a series of multi-channel with different widths. The ten 67 nm-wide split channels TFT has best gate control due to its tri-gate structure, and has lowest poly-Si grain boundary defects, which were passivated by NH_3 plasma effectively due to its split nano-wires structure. The proposed TFT exhibits high performance electrical characteristics, such as a high ON/OFF current ratio ($>10^9$), a steep subthreshold slope (SS) of 137 mV/decade, an absence of drain-induced barrier lowering (DIBL), suppressed kink-effect, and superior reliability. [C2846]

"Integrating EU advanced manufacturing research"

Manufacturing research within the EU tends to be fragmented with work being conducted by many organisations in an uncoordinated way. This results in duplication of resources and efforts and of funding for research at regional, national and EU levels. Networks of Excellence (NoEs) are a new 'instrument' introduced into the Framework Six Programme (FP6) by the European Commission to overcome fragmentation of European research. This article gives examples of two NoEs coordinated by the Manufacturing Engineering Centre at Cardiff University to help integrate EU research in advanced manufacturing. The I*PROMS NoE contributes to this goal by strengthening the European research base in the umbrella area of Innovative Production Machines and Systems. The 4M NoE in multi-material micro manufacture integrates facilities and creates synergistic links to on-going R&D programmes to develop micro and nano manufacturing technologies (MNT) for the batch-manufacture of micro-components and devices in a variety of materials [C2847]

"NanoPhysics of electron dynamics near surfaces in high power microwave devices and systems"

Recently, a consortium comprising the above indicated universities have been awarded a five year Multidisciplinary University Research Initiative (MURI) program aimed at providing a fundamental understanding of RF breakdown phenomena and developing novel, high current density cathodes. The start date is June 1, 2004 and this talk will focus on both the initial activities and long term directions. The above goals will be accomplished by addressing two underlying issues: "pulse shortening" caused by RF breakdown and the lack of suitable, robust high current density cathodes. RF breakdown is a phenomenon that is poorly understood with respect to both the "nano-physics" of its inception as well as the techniques to minimize its effects. Understanding it and preventing it require coordinated experimental and simulation programs. The cathodes required for so-called high power microwave (HPM) sources must provide in excess of 100 A/cm and conventional thermionic cathode technology falls short of that current density by about a factor of 5. Cathode studies will employ laser deposition techniques with the goal of achieving up to 200 A/cm emission from oxide and scandate based thermionic cathodes at relevant lifetimes. Both advanced field emitter array (FEA) and carbon nanotube (CNT) based field emitter arrays will also be developed, along with integrated active control elements, for higher current density cathodes. We will employ two kinds of nanotube structures for this purpose: high-density vertically aligned nanotube towers and gated individual nanotube field emitters. We will develop triode-like gated individual nanotube field emitters by performing controlled synthesis to grow individual vertical nanotubes at desired sites. To investigate the RF breakdown issue, we will implement a comprehensive experimental and computational program. RF breakdown experiments will be conducted in a resonant single-cell cavity, configured as a "windowtron" and fed directly by a 50-MW X-band SLAC klystron. This experimental arrangement was used in a previous MURI and was found to be much more effective than an earlier method of

inserting the cavity in a resonant ring to provide the required sustained power. Computational studies will include computer modeling of the breakdown dynamics in the actual cavity geometry using a newly developed parallel processing version of MAGIC 3D. To gain clearer insight into the physics of RF breakdown, a microscopic model will be developed. [C2848]

"Analysis on data retention time of nano-scale DRAM and its prediction by probing the tail cell leakage current"

Characteristics of the data retention time (tRET) of nano-scale DRAM have been described. In addition, new approaches to enhance tRET and their properties have been analyzed. To optimize the process, we developed the tRET-modeling methodology, which has a good agreement with experimental data. The key feature of the methodology is an indirect probing of the tail leakage current by fitting the leakage model to reproduce the measured characteristics of the retention. The model shows the GIDL current is a major factor determining tRET of 80nm RCAT technology. [C2849]

"2004 International Electron Devices Meeting (IEEE Cat. No.04CH37602)"

{no data available} [C2850]

"Implantable flexible wireless pressure sensor module"

A chip embedded flexible packaging scheme has been developed using a thinned silicon chip. Mechanical characteristics of thinned silicon chips are examined by bending test and finite element analysis. Thinned silicon chips (t [C2851]

"Impact of metal gate work function on nano CMOS device performance"

We studied two effects in the metal gate work function engineering in nano CMOSFETs: (1) Gate work function shifts induced by carrier quantization in Si and Ge ultra-thin body FETs with sub-10 nm body thickness and different surface orientations. Guidelines for metal gate work function engineering are provided and technical challenges identified; (2) we presented a systematic study on gate tunneling characteristics of metal gate CMOSFETs. A reduction of gate to source/drain extension tunneling is found when using near mid-gap metal gate in SOI CMOS, especially when using high-K dielectric. Benefits of this reduction to transistor off-state leakage and to future CMOS scaling were analyzed. [C2852]

"3-dimensional nano-CMOS transistors to overcome scaling limits"

Among the several approaches to overcome the scaling limit of silicon devices, in this paper we introduce recent achievements in the fabrication of transistors for SRAM, DRAM and Flash memories as well as the logic devices with high performance requirement. Among them are S3 (stacked single-crystal silicon) cell for SRAMs, RCAT (recessed cell array transistor), PiFET (partially-insulated MOSFET) and FinFET for DRAMs and MBCFET (multi-bridge channel MOSFET) for high performance logic applications. These 3 dimensional devices are easily adapted to the products showing excellent performance. [C2853]

"Design guidelines of nano-scaled SOI-DTMOS device"

The paper suggests nano-scaled SOI-DTMOS and expects to obtain high performances with standard technology, and relax the critical requirement of silicon film thickness for conventional SOI to provide greater design choices of nano-scaled devices. The paper compares scaling-down capabilities of the devices at nanometer and points out the advantages of SOI-DTMOS. In details, the paper discusses the critical structure parameter-silicon film thickness. From research we find that at nano-scaled gate lengths the novel device SOI-DTMOS with excellent performances of both high speed and low power, is able to relax the critical requirement of silicon film thickness that strictly limits the application of conventional body-floating SOI. Finally, the paper provides general guidelines for choosing on the basis of analyzing SOI-DTMOS device physics, and obtains proper parameter values for the practical manufacturing. [C2854]

"Heterogeneous integration of nano devices on Si CMOS platform"

This paper outlines the limits on traditional scaling of CMOS and beyond, as well as the possibilities of introducing novel materials, their devices and the organization of these structures. From these organized structures, new local information processing architectures beyond CMOS may be possible. In addition to achieving continuous improvement of performance following Moore's Law, another benefit of integration is to have more functions on a Si platform. Thus, the potential of heterogeneous integration of self-assembly wires,

dots, and molecules, with nanometer scale feature sizes on a Si CMOS platform may lead to future integrated nanosystems, incorporating many functions beyond traditional electronics. Nanostructures enable reduction of defects and they may be formed without rigid conformation to the crystalline structure of the substrates, or in other words, they are relatively free from constraint of the crystalline substrates. Thus, high performance devices and circuits may be integrated in a large area. One of the major issues for continuous increase of integration level is the increase of power dissipation per unit area on chip. We examine this critical issue of integrated circuits from a fundamental point of view of power dissipation. In order to alleviate the power dissipation issue, we study locally active devices, which may be built from homogeneous to form computational systems. Systems, such as cellular automata, cellular nonlinear networks, and other similar architectures, may be explored for low power application using nanometer scale devices and their integration. [C2855]

"Amperometric biosensors and potentiometric pH-microsensors integrated into AFM tips"

Summary form only given. Scanning electrochemical microsensors offer unique advantages by combining laterally resolved information on electroactive surface processes with high sensitivity and selectivity. In order to position and scan nano- and microsensors at a constant distance across the sample surface, we developed combined scanning probes by integrating micro- and nanoelectrodes into AFM tips using microfabrication and focused ion beam (FIB) techniques. Further modification of the integrated electroactive area enables the implementation of microbiosensors by immobilizing a biological recognition element or by integrating a potentiometric pH sensor using a metal/metal oxide layer such as iridium/iridium oxide. The presented approach allows laterally resolved imaging of ATP concentrations above epithelial cells during AFM imaging and monitoring cellular ATP release. pH-changes in microenvironments can be laterally resolved with integrated AFM-pH nanosensors. [C2856]

"Nanofabrication based on MEMS"

In this paper, a novel nanofabrication method that developed from the traditional MEMS technology with anisotropic etching, deep reaction ion etching and sacrificial layer process has been presented. Nano needles, nano wires, nano beams even nano devices can be fabricated in a batch process. Beams with thickness of 12 nm, a nano tip with a heater on the beam, and a nano wire where width and thickness is only 50 nm are demonstrated. The scale effect of the Young's modulus of silicon has been observed and the nano-electronic-mechanical data storage has been achieved. [C2857]

"2004 7th International Conference on Solid-State and Integrated Circuits Technology Proceedings (IEEE Cat. No.04EX862)"

{no data available} [C2858]

"Analysis of platinum bond pads on polyimide soft substrate for wire bonding with Au wire using nano-indentation technique"

The thermosonic gold wire bonding is a common technology in microelectronics industry for reliable bonding. The bondability of metallisation on soft material like polyimide (PI) is a matter of concern, especially when the bond pads are made of thin coating of platinum material. Nano-indentation technique is commonly used to measure surface properties of thin film coatings, such as Young's modulus and hardness within sub-micron scale. Four different samples were produced by sputtering different thickness of Pt on polyimide substrate to study the behaviour of thickness versus applied load of indenter. The nano-indentation data regarding "load versus displacement" and "hardness versus displacement" for all the four samples were collected and deformation behaviour and mechanical properties of thin film platinum material had been investigated. In this paper, the analysis of platinum pads has been carried out and it was observed that the samples with 300 nm platinum layer on polyimide were bonded well as compared to 100 nm thickness of platinum material. [C2859]

"Microfluidic chips for the molecular analysis of human cancer"

Although the large-scale analysis of the human genome has provided a wealth of information for the genetic analysis of cancer and other diseases, most of these advances are unavailable in the clinic due to their expense and complexity. The development of miniaturized devices capable of automated real time analysis of genetic profiles is likely to enable routine genetic analysis of diseases such as cancer, whether for diagnosis or for monitoring treatment throughout the course of the disease. Microfluidic chips allow detection of mutations and abnormal gene expression patterns. Here, we describe the application of microfluidic chips for the molecular monitoring of gene expression profiles associated with human cancer. On-chip RT-PCR products are detectable after as few as 15 cycles of PCR, and from individual cells. On-chip detection is as sensitive as or exceeds the

sensitivity obtained using conventional technologies. [C2860]

"Super-fine ink-jet printing for nanotechnology"

We introduce an ultra-fine inkjet system as a powerful tool for nanotechnology research which allows arrangements of dots with a minimum size of less than one micron. Diverse materials such as conductive polymers, fine ceramics, metal particles etc. can be used as ink materials. Using the ultra-fine silver paste, we achieved the direct print of ultra-fine metallic wire of only a few micrometers in width without any pre-patterning treatment on substrate. Furthermore, using the transitionmetal nano-particles as catalyst-ink, patterned array of carbon nano-tubes were successfully obtained. A field emission from the patterned carbon nano-tubes is also confirmed. [C2861]

"The emergence of high-density semiconductor-compatible spintronic memory"

After many years of research and development, megabit-density spintronic memory, also called magneto-resistive random-access memory (MRAM), may be on the verge of commercial production at several companies, including Honeywell International Inc., Cypress Semiconductor Corp., IBM Corporation, and Motorola Inc. MRAM has been touted as being a universal memory technology, with the high speed of SRAM, the nonvolatility of flash memory (but with much greater erase-write endurance than flash memory), and with storage densities approaching those of DRAM. MRAM is also promoted as being embeddable in conventional CMOS processes with as few as four additional mask steps. Similar advantages are also claimed by proponents of at least two other emerging candidate universal memories: ferroelectric memory and chalcogenide-based phase change memory. This paper focuses on MRAM, and briefly surveys the most promising MRAM technologies, including anisotropic MRAM, spin valve MRAM, pseudo spin valve MRAM, and magnetic tunnel junction MRAM (MTJ-MRAM). [C2862]

"Application of adaptive multilevel substructuring technique to model CMOS micromachined thermistor gas sensor, part (II): effect of manufacturing uncertainties in the reliability of MEMS"

For pt.I, see *ibid.*, no.54, p.279-84 (2003). A study has been conducted to investigate the effect of the manufacturing uncertainties on the reliability of MEMS. The parameters investigated, include the uncertainties in the characterization of the Young's modulus and the values of the residual stresses generated during the deposition process of MEMS thin films. The study was conducted on a CMOS micromachined thermistor gas sensor, recently proposed in the literature. A novel technique called adaptive multilevel substructuring was used to reduce the computational cost of the analysis. The numerical results suggest that, the uncertainty in the characterization of Young's modulus has a reduced effect on the fatigue life. At the other hand the change in the value of the residual stress has a significant effect in the maximum operational stress level encountered during the operation, equivalent alternating stress value and consequently on the expected operational life of the MEMS component. The maximum expected life was found to occur at residual stresses values ranging from 0 to 400 Mpa. At these residual stresses values, the equivalent alternating stress is found to be lower than the endurance limit of the material. These values of the residual stresses correspond to a deposition temperature of 850°C and a SiH₂Cl₂/NH₃ ratio ranging from 2 to 4 for the Si₃N₄ film deposition process. The achieved results emphasize the important role that can be played by the numerical modeling of the end product. Using the numerical modeling, conclusions for the process parameters can be evaluated before proceeding to the actual microfabrication process. [C2863]

"Characteristics of nano electron source fabricated using beam assisted process"

In this study, nanoelectron sources have been fabricated using a beam-assisted maskless process alone. The process uses chemical reactions by electron beam (EB) or focused ion beam (FIB) in various gas atmospheres. The gate diameter, shape and emitter height of nano electron sources can be freely designed and fabricated. The I-V characteristics of fabricated nano-electron sources have been measured. [C2864]

"Interface characterization methodology for nano-CMOS reliability-process and device reliability monitors"

Interface characterization is fundamental to the understanding of device reliability as well as the process monitoring, in particular for the development of an efficient tool for analyzing the hot carrier reliability of ultra-thin gate oxide CMOS devices. This paper will cover an overview of advanced charge pumping (CP), DCIV, Gated-Diode (GD), techniques for the interface characterization of CMOS reliabilities. Its potential use for the device reliability study, and oxide quality monitoring for the state-of-the-art CMOS technology will be presented. More recent developments for nano-CMOS device applications will be demonstrated. Moreover, further development

and the roadblocks of these techniques will be addressed. [C2865]

"Technology of ultrasonic finishing treatment for locomotive wheel pair type"

An increase of wear resistance and improvement of tribotechnical properties of wheels of locomotives is an urgent scientific and technical problem. In the forefront are the questions, connected with the improvement of properties of surface wheel flanges and transformation of the surface layer structure. The application of ultrasonic finishing treatment enables to solve the given problem completely. The first stage in the solution of the problem was the research of influence of the ultrasonic treatment on the structure and physical and mechanical properties of the ferrite-pearlite steel wheel and matching optimum modes of processing. Integrated researches of morphology of a surface, macro and microstructure, nano- and microhardness, hardness and wear resistance of wheel tread with ultrasonic treatment, obtained in manufacturing, set outcomes of preliminary researches. The obtained outcomes enabled to offer the given technology for the usage when repairing and producing railway wheel pairs. [C2866]

"Micromachined needles for microbiological sample and drug delivery system"

In this paper, the research and development of micromachined needles for microbiological sample and drug delivery system are reviewed. The micromachined needles can be classified into in-plane and out-of-plane needles. The features of those microneedles are analyzed and discussed. In addition, the design criteria of micromachined needles are proposed. At the same time, the further research of micromachined needles is also discussed. Based on those analysis, a new microneedle structure has been proposed. [C2867]

"Spintronics, and electrical spin injection in a two dimensional electron gas"

The manipulation of electron spin offers new dimensions for basic and applied research, and the potential for new capabilities for electronics technology. Interest in digital electronics applications has spread to a variety of information systems and generated need for new devices, such as a Spintronic device with power gain. This motivates transport studies of spin polarized electrons in a high mobility two dimensional electron gas (2DEG). Recent experiments have used an FET-like geometry with ferromagnetic metal source and drain, as spin injector and detector, on an InAs single quantum well (SQW) channel, and a measurement of the spin dependent electron mean free path in the SQW has been made. An overview of Spintronics, including discussions of integrated applications in memory, reprogrammable logic, system-on-a-chip, and biotechnology, provides a broader context for this work. [C2868]

"Success factors in commercializing university MEMS technology through the WTC's microfabrication laboratory"

The Washington Technology Center, a state-chartered science and technology organization, headquartered at the University of Washington in Seattle, began its MEMS Initiative in 1997 to build core capabilities at the state's universities and to foster commercialization of university-developed MEMS technology. Key to the success of the Initiative was establishment of the WTC's Microfabrication Laboratory a 15,000 sq. ft. user-supported cleanroom facility for academic and industrial MEMS research, development, prototype product manufacturing and foundry processing. Since that time, the Microfab Lab has grown to become the premier MEMS fabrication facility in the Pacific Northwest, with 180 users from 40 academic research groups and 30 private companies, and annual revenues approaching \$1 M. This paper will cover the key success factors and lessons learned in commercializing micro-technology through start-up companies and industry-university partnerships over the past 6 years. The evolution of the Microfabrication Lab, in particular, will be described to illustrate how technical capabilities, laboratory management and business planning were adapted to attract and meet the needs of a growing user base. [C2869]

"Multi-patch: a chip-based ion-channel assay system for drug screening"

Ion channels are cellular membrane proteins that act as specific signal transducers. They have crucial roles in physiology and pathophysiology and are important drug targets. Patch-clamp is the gold-standard for assessing ion channel function but does not have the potential to be automated and parallelized. This fact underlies current efforts in developing parallel patch-on-chip platforms in order to provide higher throughput and better reproducibility. Our approach is to develop a bio-electronic sandwich interface between microstructured substrates and printed circuits. 'Multi-patch' is a patch-on-a-chip device replacing patch pipettes by micrometer-sized holes and enabling multiple simultaneous single-cell electrical measurements. We present here a comparative approach of different substrates in view of the development of a chip-based device. We emphasize on the silicon technology pointing out its advantages in terms of microstructuration and development of an integrated electronics. [C2870]

"Micro and nano sensors snoop around"

"Summary form only given". Vision and hearing, smell and taste, and the tactile senses are bridges between the external world and our brain. Micro and nano sensors are miniaturized electronic devices which pick up physical, chemical, or biomedical signals and enter them into the computer. The miniaturization of most kinds of sensors has been achieved, but the "electronic nose" able to detect a broad range of "smells" caused by complex mixtures of airborne chemical compounds is still a dream. But application specific gas sensors or "narrow band noses" are being developed, which can detect and identify gas mixtures in given application areas, such as air conditioning, dry cleaning, oil refineries, or food production. Integrated gas sensors based on CMOS IC technology with on-chip micro structures (CMOS MEMS) coated with gas absorbing polymers or metal oxides are presented. The quest of sensor selectivity is tackled by combining various polymers with different transducer principles (mass sensitive, capacitive, calorimetric). The combination of different types of transducers on a single CMOS MEMS chip with dedicated circuitry, and the assembly of several such chips, each with different chemically sensitive polymer layer, in a handheld "snooping instrument" are discussed. An outlook will address the combination of CMOS MEMS with bio materials and living cells. [C2871]

"Application of adaptive multilevel substructuring technique to model CMOS micromachined thermistor gas sensor, part (I): A feasibility study"

A study has been conducted to investigate the feasibility of using the multilevel substructuring method to perform parametric analysis for MEMS devices. The feasibility study was conducted on a CMOS micromachined thermistor gas sensor. Two multilevel substructuring methods were used, mainly the cumulative and nested superelements methods. The interface problem was found to increase rapidly with the increase in the number of superelements for the cumulative technique. On the other hand, the nested superelements technique was found to provide an almost fixed and much more reduced interface problem. The results show that, for the same number of reduced elements, the nested superelements method provides a better speedup factor (2.36-4.61) compared to the cumulative method. In the current study, two strategies were used to deal with the nonlinear thermal analysis of the microheater. In the first strategy the substructuring was only limited to the linear portions of the model. In the second strategy the substructuring was extended to include portions of the model with a reduced nonlinearity. The second strategy increased the computational savings by a percentage of 20%, compared to the first strategy with a reasonable loss of accuracy of only about 3%. [C2872]

"Computational patent mapping: Intelligent agents for nanotechnology"

Patents are an important source of technological intelligence that companies can use to gain strategic advantage and computational patent mapping is a methodology for the development and application of a technology knowledgebase for technology and competitive intelligence. The primary deliverables of patent mapping is in the form of knowledge visualization through landscape and maps. This paper applied computational patent mapping techniques in the area of nanoagent and several dominant nanoagent themes have been identified by the visualization of a patent dataset presented in the form of a patent landscape for nanoagents. This study reveal insights into nanoagents patent technology S-curves, patenting activities of various nanoagent players over time, the development in nanoagent enabling technologies over time and selected patent with high QS-Index. [C2873]

"Quadrupole-mass-spectroscopy studies on hot filament chemical vapor deposition of carbon films with nano-sized constituents"

We used a quadrupole mass spectrometer (QMS) to investigate the dissociation of source gases and the variation of the gas-phase precursors during the HFCVD process. Since the HFCVD pressure was about 30 Torr, a capillary was installed to sample the gas from the HFCVD chamber while maintaining the QMS at high vacuum. An investigation of the systematic variations in mass spectra corresponding to the increase of methane concentration in the ammonia-free feed gases revealed substantial generation of species containing two carbon atoms. However, an increase of ammonia concentration in the feed gas with 20% of methane resulted in generation of nitrogen containing radicals such as CN and HCN together with the suppression of two-carbon radicals. An implication of observed mass-spectrum variation for the growth behavior of carbon nanotube (CNT) and/or carbon nanoparticle (CNP) films was discussed. [C2874]

"Enhancement of magnetoresistance by inserted nano oxide layer in Mn-Ir bottom spin valve"

Summary form only given. High output signal and easy controlling of bias point are necessary to achieve 100 G/bit² magnetic areal density in magnetic recording technology. Specular spin valve in which the NOL enhance specular electron scattering and smooth interface were suggested as a new technology. In this paper, we studied

effect of nano-oxide layer (NOL) formation at the interface between ferromagnetic layers and investigated chemical bonding of NOL. Si/Ta(5nm)/NiFe(3.5 nm)/Mn-Ir(6 nm)/CoFe(2 nm)/NOL/CoFe(2 nm)/Cu(2.5 nm)/Co-Fe(t nm)/Ta(2.5 nm) specular bottom spin valves were deposited on Si(100) substrate by auto-process magnetron sputtering. The base pressure was less than 3×10^{-8} Torr. The samples were deposited under 5 mTorr. A NOL was formed in the load lock chamber by exposing to pure oxygen gas. Samples were annealed for 30 min at 200°C under 3 kOe in-plane magnetic field in a vacuum furnace (1×10^{-5} Torr), followed by cooling to room temperature for 2 hour. The magnetoresistance (MR) and the exchange bias field (H_{e}) increased from 7.8 and 247 without NOL to 10.2 % and 320 Oe with NOL, at $t = 40$ nm, respectively Also the coupling field (H_f) and sheet resistance (R_s) decreased from 35 and 4.9 without NOL to 19 Oe and 4.67 Q/sq with NOL, respectively. In case of using NOL the decreased sheet resistance indicates that the probability of spin dependent scattering of conduction electrons is increased because electrons have long mean free path in the ferromagnetic layers. Improved magnetic properties of spin valve by inserted NOL are considered to be due to the specular effect. The values of rms, peak-to-valley and average roughness decreased from 1.46, 45.3 and 0.92 to 1.32, 15.5 and 0.81 nm, after O₂ exposure This indicates that the interface greatly smoother by NOL formation. This uniform interface reduce ferromagnetic static coupling between two ferromagnetic layers XPS results showed that NOL was constituted from about 31 % Fe₂O₃ and about 51 % FeO. And Co-oxide was negligible. TEM will be presented in more detail microstructure of specular spin valve. [C2875]

"Plasma diagnosis and end-point detection with an optical emission spectroscopy during high density inductively coupled BCl₃ plasma etching"

Plasma diagnosis and end-point detection technology with optical emission spectroscopy is getting attention for precise control of dry etching process. Especially, optical emission spectroscopy can be a very useful tool for monitoring of dry etching of compound semiconductors. OES technology does not interfere plasma processing during monitoring. [C2876]

"Simulation of directional Si etch with various neutral beam angle distributions"

As the size of semiconductors is reduced to nano-scale, an influence of plasma process induced damage (PPID) is increased. Etch process using neutral beam is suggested to reduce PPID. We have performed a neutral beam simulation to obtain an outstanding etching process. The neutral beam is generated from collision between ions produced by ion-gun and reflectors. Ion-gun is simulated by XOOPI code for high ion flux and good directionality of ions. We have carried it out by the variations of ion-gun parameters such as grid voltage, grid interval and pressure. For neutral beam simulation, we have used the modified XOOPI code at which reflection characteristics obtained by TRIM code are appended. Neutral flux, energy and angle distribution are calculated by the variations of ion-gun type and reflection conditions (angle and length of reflector). We have studied a directional etching by an influence of neutral angle distribution at the shallow trench of silicon. As anti-reflection coating is spread on sidewall, it is analyzed that sidewall etching is reduced by anti-reflection coating. Therefore, we find optimized conditions for high neutral flux and good neutral angle distribution. [C2877]

"Nano imprint technology with artificially assisted self-assembling patterns for recording media"

In this paper, we have developed a new fabricating method of patterned media which includes nano-imprint lithography and fine nano-patterning using the self-assembly of diblock copolymer. [C2878]

"Nanotechnological, two-stage production processes"

In the paper, the production processes of a nano-products fabrication consisting of two main stages is described. In the first stage, an "intermediate product" is created, with linear, molecular structure identical to linear sequence in a final product. In the second stage, that flat, linear structure will convert into a spatial shape of molecules representing the final product. The operations performed in those systems are based on nanotechnologies or a "bottom-up" creation of the product. This approach to the product creation requires a knowledge about the product molecular constitution and the phenomena observed on the surface of molecules and atoms, which allow for a design of a proper, "gluey matrix". This matrix introduced into a mixture of freely moving molecules (building blocks) concentrates and integrates the building blocks on the surface of matrix forming the needed intermediate product. In the last, second stage, the intermediate product created and next detached from the surface of gluey matrix is a substrate for the creation of appropriate final product by affecting the intermediate product with various external stimuli, assuring the proper conformational modifications. [C2879]

"Recent advances in nanotechnology: key issues & potential problem areas"

Recent developments in nanosciences and nanotechnology have created tremendous enthusiasm among researchers and scientists across the globe. The rapidly increasing interest among various engineering

disciplines toward research and development needs of nano-domain have spurred the growth in areas such as nanoelectronics, biotechnology & health delivery system and commerce in general. In this paper, a state-of-the-art encompassing the recent developments and the key problems in nanomanufacturing that relate to the domain are presented. Furthermore, contribution in this field from the researchers in different parts of the world are included and compared to monitor the present progress. With the down sizing of present silicon, IC technology, validity of Moore's law has become seemingly limited. However, it is strongly believed that the novel materials will provide the answer for further scaling of device density and performance. For example, most recent attention has been paid on carbon nanotubes, which can be used in nanosize electronic devices. It is still a question whether nanotube based technology will actually contribute to the existing CMOS technology or it is a totally new device architecture from CMOS technology. Besides, it is unclear whether this material will meet scalability, durability and existing performance. Modelling and simulation is a vital element for gaining insight to the behaviour of these materials and also to the characterization process. A part of this paper will be devoted to fully analyze the current trends in nanoelectronics based on nanostructured materials other than silicon. [C2880]

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First Page of the Article [C2881]

"Imaging at the nano-scale"

Surface characteristics such as topography and critical dimensions serve as important indicators of product quality and manufacturing process performance especially at the micrometer and the nanometer scales. This paper first reviews different technologies used for obtaining high precision 3-D images of surfaces, along with some selected applications. Atomic force microscopy (AFM) is one of such methods. These images are commonly distorted by convolution effects, which become more prominent when the sample surface contains high aspect ratio features. In addition, data artifacts can result from poor dynamic response of the instrument used. In order to achieve reliable data at high throughput, dynamic interactions between the instrument's components need to be well understood and controlled, and novel image deconvolution schemes need to be developed. Our work aims at mitigating these distortions and achieving reliable data to recover metrology soundness. A summary of our findings will be presented. [C2882]

"The effect of bias voltage on the measurement of local barrier height"

In this paper a relation among tunnel current, bias voltage and tip-specimen separation is examined based on Simmons' formula under constant LBH assumption. It has been shown that to understand the effect of bias voltage on LBH, measurement has to be carried out under constant tip-specimen separation, not under constant tunnel current as normally used. Measuring local barrier height with STM is a very powerful way of investigating surface potential of nano- or atomic structure. [C2883]

"Low field electron emission from nanocluster carbon films grown using a pulsed trigger less cathodic arc process"

Nanostructured carbon based electron emitters are now in the forefront, as one of the best candidate for cold cathode based field emission applications. Various forms of carbon including, nano-diamond, carbon nanotubes, nanostructured graphite, nano horns, nanocluster carbon, diamond like carbon [DLC], tetrahedral amorphous carbon [ta-C], etc., have been all shown to emit electrons at reasonably low fields. These materials have been grown using different process like hot filament CVD, microwave plasma CVD, Plasma assisted DC discharge, cathodic arc etc., The need is for a low temperature, large areas capability, low cost process, compatible with silicon process technology. The Cathodic arc offers the unique opportunity of growing any form of carbon, from highly sp³ bonded material like diamond to highly sp² bonded graphite like material such as carbon nanotube and all the intermediate stages including DLC, ta-C and nanoclusters at near room temperature. The process may also be scaled up, for large area film growth. [C2884]

"Laboratory facilities of the microsystems technology laboratories (MTL) at Massachusetts Institute of Technology"

MTL is an Interdepartmental Laboratory of the Massachusetts Institute of Technology (MIT) whose mission is to provide the facilities necessary to carry out research in nano- and microsystems and structures. In accordance with the multidisciplinary nature of microsystems technology, the faculty, staff, and students using MTL are affiliated with the many schools, departments, and centers of MIT. [C2885]

"Silicon nano-transistors and breaking the 10 nm physical gate length barrier"

In this paper, the performance and energy delay trends for research devices down to 10 nm and also discusses the 10 nm barrier and potential ways to break it were explored. [C2886]

"Teaching vacuum technology using spreadsheet calculations"

Vacuum technology is an important part of nano-fabrication. Automated control systems for vacuum equipment have made operation easy and safe but have also isolated the user from the need to understand the physics of vacuum systems. In spite of this, many equipment and process decisions revolve around choices made concerning the vacuum components of a processing tool. Students can use a spreadsheet to calculate the pump down pressure characteristic in a chamber for various non ideal conditions and combinations of single and multiple stage pumps. The calculations can be compared to characteristics of real pump/chamber systems that are available in the user's laboratory. This develops a much deeper understanding of the design and operation of modern vacuum systems. The calculations are also a good way to introduce or review numerical techniques. [C2887]

"An overview of Double-Gate MOSFETs"

The Double-Gate (DG) Fully Depleted (FD) SOI MOSFET, and its many implementations, is the leading device candidate for Silicon nano-scale CMOS. Their main characteristics, as compared to the single gate bulk MOSTET, are less S/D capacitance, larger saturated current drive, smaller short channel effects (DIBL), scalability to $L=10$ nm, near ideal subthreshold slopes (S), and the possibility of electrically adjustable threshold voltages. [C2888]

"Transition of MEMS technology to nanofabrication"

The transition of MEMS technology to nano fabrication is a solution to the growing demand for smaller and high-density feature sizes in the nanometer scale. Techniques for fabricating μm -, and nm-features will be discussed, and results achieved with nanoimprinting technologies will be presented. [C2889]

"Single molecule nano-bioscience"

Summary form only given. Biomolecules assemble to form molecular machines such as molecular motors, cell signal processors, DNA transcription processors and protein synthesizers to fulfill their functions. Their collaboration allows the activity of biological systems. The reactions and behaviors of molecular machines vary flexibly while responding to their surroundings. This flexibility is essential for biological organisms. The underlying mechanism of molecular machines is not as simple as that expected from analogy with man-made machines. Since molecular machines are only nanometers in size and has a flexible structure, it is very prone to thermal agitation. Furthermore, the input energy level is not much difference from average thermal energy, kBT. Molecular machines can thus operate under the strong influence of this thermal noise, with a high efficiency of energy conversion. They would not overcome thermal noise but effectively use it for their functions. This is in sharp contrast to man-made machines that operate at energies much higher than the thermal noise. In recent years, the single molecule detection (SMD) and nano-technologies have rapidly been expanding to include a wide range of life science. The dynamic properties of biomolecules and the unique operations of molecular machines, which were previously hidden in averaged ensemble measurements, have now been unveiled. The aim of our research is to approach the engineering principle of adaptive biological system by uncovering the unique operation of biological molecular machines. I survey our SMD experiments designed to investigate molecular motors, enzyme reactions, protein dynamics, DNA transcription and cell signaling. [C2890]

"Rayleigh diffraction limit on photolithography relaxation using non-linear optical devices"

The main disadvantage of the traditional photo-lithography and main problem for high level integration in microelectronics and photonics engineering is minimum line width which is determined by Rayleigh diffraction limit. In this work, we examine the relaxation condition of this trouble using non-linear optical effects. We show that, increasing threshold value in the reflective type non-linear optical devices can decrease the minimum line width. Therefore, our idea can be suitable approach for nano-technology device and system implementation. [C2891]

"Nano-teslameter for characterization of the fields emitted and received by wound electronic components."

First Page of the Article [C2892]

"Localized synthesis of silicon nanowires"

Localized resistive heating of microstructures has been used to activate vapor-deposition synthesis of silicon nanowires in a room-temperature chamber. The process is localized, selective, scalable and compatible with on-chip microelectronics and, in addition, removes necessity of post-synthesis assembly of nanowires to accomplish integrated nano-electromechanical systems. Synthesized nanowires with dimensions of 30-80 nm in diameter and up to 10 μm in length have been successfully demonstrated and growth rates of up to 1 $\mu\text{m}/\text{min}$ have been observed. This new class of manufacturing method enables direct integration of nanotechnology with larger-scale systems for potential sensing and actuation applications. [C2893]

"Mechanical characterization and modeling of low-dielectric-constant SiLK films using nano-indentation: time- and temperature-effects"

First Page of the Article [C2894]

"TRANSDUCERS '03. 12th International Conference on Solid-State Sensors, Actuators and Microsystems. Digest of Technical Papers (Cat. No.03TH8664)"

First Page of the Article [C2895]

"MEMS-fabricated ICPE grippers for aqueous applications"

This paper presents the results of our ongoing investigation of using Nafion solution to construct micron scale actuators as grippers for underwater manipulation. We have demonstrated MEMS-based fabrication of cantilever structures composed of Au/Nafion/Au film layers on silicon substrates is possible. The smallest actuators fabricated were 30 μm wide, 300 μm long and 0.4 μm thick. We have shown that 2-finger actuators (each 100 μm wide, 1200 μm long and 0.4 μm thick) could be fully actuated in water at 7 V DC. In addition, we have found that micro Au/Nafion/Au cantilevers can respond to pH level changes in a solution environment, suggesting that they could potentially be used as biological sensors. [C2896]

"Focused ion beam (FIB) nano-machining and FIB Moire technique for strain analysis in MEMS/NEMS structures and devices"

The accurate determination of residual strain/stress in thin films is especially important in the emerging field of MEMS/NEMS. In this paper, a focused ion beam (FIB) Moire method is proposed and demonstrated to measure residual strain/stress in microstructures. This technique is based on advantages of the FIB system in nano-machining, in-situ deposition, imaging, and fine adjustment. A nano-grating is directly written on the top of the microstructures by ion milling without any etch mask; the FIB Moire pattern is formed by the interference between a prepared specimen grating and raster scan lines. Since the local strain of a microstructure itself can be monitored during the process, the FIB Moire technique has many potential applications in the mechanical metrology of MEMS. [C2897]

"Bulk carbon nanotubes as sensing element for temperature and anemometry micro sensing"

Bulk multi-walled carbon nanotubes (MWNT) were successfully and repeatably manipulated by AC electrophoresis to form resistive elements between Au microelectrodes and were demonstrated to potentially serve as novel temperature and anemometry sensors. We have measured the temperature coefficient of resistance (TCR) of these MWNT bundles and also integrated them into hot-film anemometry constant current configuration for dynamic characterization. It was discovered that the resulting device could be operated in μW range, which is three orders of magnitude lower than conventional MEMS polysilicon based shear stress sensors. For example, to achieve a resistance overheat ratio in the magnitude of 0.1, only 10 μA of current is needed to heat these MWNT bundle elements compare to mA current range for polysilicon-based sensors. Moreover, the device exhibited very fast frequency response (>100 kHz) in constant current mode, which is higher than its reported MEMS polysilicon counterparts in this mode of operation. Our current processing technology is scalable in producing these MWNT sensing elements ranging from 5 μm to 15 μm in length. [C2898]

"MEMS-based nano probe technology for data storage applications"

Summary form only given. Data storage technology has evolved in two predominant directions in recent years, reflecting the two critical demands of large capacity and fast access. These two directions, embodied by hard disk drives (HDD) for the first direction, and random access memory (RAM) for the second one, have demonstrated phenomenal improvements in performance. The question arises as to whether one can envision an

alternative technology that will combine the capacity of an HDD and access time of a RAM, within dimensions on the order of only several mm². A novel approach that is discussed involves the implementation of several concepts that have recently been advanced in the emerging field of nanotechnology. In particular, scanning probe microscopy using a large number of cantilevers operating in parallel offers a unique opportunity that is currently being pursued by several research groups at universities and companies around the world. [C2899]

"Equivalent circuit models for stacked spiral inductors in deep submicron CMOS technology"

Series connected stacks of spirals in different metal levels facilitate on-chip high value inductance (hundreds of nano-henry without any extra penalty on area) for IF applications as well as compact inductance for RF applications. This paper presents SPICE compatible lumped element equivalent circuit models for these stacked metal layer inductors valid up to self-resonance frequency. The extracted models have been used in the design of a heterodyne down converter mixer for WCDMA applications. Simulations show that use of high value on-chip inductance in the design yields a 2 dB improvement in the conversion gain and 2.5–3.5 dB improvement in noise figure without any additional power consumption as compared to the standard resistive load mixer while maintaining the 1dB gain compression point. [C2900]

"Scaling issues in robot-based sensing missions"

Scaling analysis provides a systematic way to translate the performance of a system from one size domain, operating environment, etc., to another. In this paper, we identify scaling issues and present some simple results in the domain of individual mobile robots, as well as teams, swarms, etc., deployed on sensing missions. Since most robot-based sensing missions anticipate mini-, micro-, and nano-scale robots, our explicit examples focus on scaling-down of existing human-scale robot design and concepts. However the principles articulated apply equally to scaling-up situations. The topic is introduced via a simple example that shows why scaling-down of mobile robots that carry their own energy source will generally prove impractical: to obtain reasonable operating times it will rather be necessary to develop small robots into which energy can be beamed, or which can forage for energy sources in the environment. From this concrete illustrative example, the paper moves on to a higher level discussion of robot architecture and the applicability of scaling principles, to varying degrees, to all the modules, i.e., it is not exclusively a mobility issue. There follows a short discussion of how changes of scale are not inherently problematic, but to the contrary, in many cases suitable scale change provides the key to solving a difficult engineering problem. The final section is a quantitative example in which design and operating parameters of the robotic nodes of a sensor network are considered from the perspective of operating time limited by the energy cost of node-to-node communication. This example powerfully illustrates a system in which fairly modest changes contemplated range of engineering parameters result in enormous changes in the anticipated operating time of the system. [C2901]

"Numerical analysis of a coaxial line terminated with a complex gap capacitance"

A full wave numerical analysis was performed for a coaxial line terminated by a complex gap capacitance. The scattering parameters, input impedance and the spatial distribution of the electromagnetic field have been obtained in the frequency range of 100 MHz to 20 GHz for specimens 8 μm to 320 μm thick, with a dielectric constant of up to 70. It was found that the impedance characteristic of the network is affected by the LC resonance coupled with the cavity resonance. Embedding in the network an inductive component, such as section of the coaxial transmission line, allows one to decouple these two resonant behaviors. The specimen inductance is linearly dependent on the specimen thickness. At frequencies near the cavity resonance, the specimen section can be treated as a network of a transmission line with capacitance, where the fundamental mode propagates along the diameter of the specimen. The results are useful in improving accuracy of broadband dielectric measurements in extended frequency range of thin films with high dielectric constant that are of interest to bio- and nano-technology. [C2902]

"A CMOS current-controlled oscillator and its applications"

In this paper, we present the design of a new current-controlled oscillator (ICO). The control current of this ICO is in a nano or sub-nano Ampere range and the sensitivity of the frequency of its output voltage to the control current is about 700 MHz per μA . The circuit can operate with a low supply voltage, e.g. VDD [C2903]

"A novel fabrication process for ultra-sharp, high-aspect ratio nano tips using (111) single crystalline silicon"

This paper presents a novel fabrication process for ultra-sharp nano tips on cantilevers with the radius of curvature of less than 10 nm using an (111) single crystalline silicon wafer. The nano tip height 15 μm , and the aspect ratio is greater than 3:1. The cone angle of the tip is 19.5°. Fabrication process is based on newly

obtained etch characteristic data on silicon (111) and the sacrificial bulk micromachining (SBM) technology. The developed fabrication process is simple and robust, and well suited for ultra-sharp, high-aspect ratio nano tips on cantilevers. [C2904]

"Ultrasonic/sonic sampler and sensor platform for in-situ planetary exploration"

The search for existing or past life in the Universe is one of the most important objectives of NASA's mission. In support of this objective, an ultrasonic/sonic mechanism is currently being developed at JPL to allow probing and sampling of rocks and to use the mechanism as a sensor platform for in-situ planetary analysis. The technology is based on the novel Ultrasonic/Sonic Driller/Corer (USDC), which requires low axial force, thereby overcoming one of the major limitations of planetary sampling using conventional drills in low gravity environments. The USDC was demonstrated to: 1) drill ice and various rocks including granite, diorite, basalt and limestone, 2) not require bit sharpening, 3) operate at low and high temperatures, and 4) operate at low average power using duty cycling. The capabilities that are being investigated include probing the ground to select sampling sites, collecting various forms of samples, and hosting sensors for measuring various properties. A series of modifications of the USDC basic configuration were implemented including an ultrasonic abrasion tool (URAT), Ultrasonic Gopher for deep drilling, and the Lab-on-a-drill. These modifications will be described in this paper. [C2905]

"Biologically inspired intelligent robots using artificial muscles"

Humans throughout history have always sought to mimic the appearance, mobility, functionality, intelligent operation, and thinking process of biological creatures. This field of biologically inspired technology, having the moniker biomimetics, has evolved from making static copies of human and animals in the form of statues to the emergence of robots that operate with realistic appearance and behavior. Technology evolution led to such fields as artificial muscles, artificial intelligence, artificial vision and biomimetic capabilities in materials science, mechanics, electronics, computing science, information technology and many others. One of the newest fields is the artificial muscles, which is the moniker for electroactive polymers (EAP). Efforts are made worldwide to establish a strong infrastructure for this actuation materials ranging from analytical modeling and comprehensive understanding of their response mechanism to effective processing and characterization techniques. The field is still in its emerging state and robust materials are still not readily available however in recent years significant progress has been made. To promote faster advancement in the field, in 1999, the author posed a challenge to the research and engineering community to develop a robotic arm that would wrestle against human opponent and win. Currently, he is considering setting up the first competition in 2005. This paper covers the current state-of-the-art and challenges to making biomimetic robots using artificial muscles. [C2906]

"Fabrication of body-tied FinFETs (Omega MOSFETs) using bulk Si wafers"

Nano scale body-tied FinFETs have been firstly fabricated. They have fin top width of 30 nm, fin bottom width of 61 nm, fin height of 99 nm, and gate length of 60 nm. This Omega MOSFET shows excellent transistor characteristics, such as very low subthreshold swing, Drain Induced Barrier Lowering (DIBL) of 24 mV/V, almost no body bias effect, and orders of magnitude lower I_{SUB}/I_{Dth} than planar type DRAM cell transistors. [C2907]

"High vertical aspect ratio LIGA microwave 3-dB coupler"

This paper focuses on microwave directional couplers fabricated using synchrotron deep X-ray lithography (DXRL), an advanced micro- and nanofabrication technology allowing the design of microwave structures with improved performance by exploring the third dimension-metal height. Demonstrated are the influence of increased metal height on the structure characteristics and performance unattainable through conventional planar fabrication techniques. [C2908]

"RF MEMS devices"

This paper addresses the use of RF MEMS devices in wireless and satellite communication systems. Novel configurations are presented for MEMS variable capacitors, MEMS tunable inductors and RF MEMS multiport switches. The tuning range of the variable capacitor was measured and found to be 280%, which far exceeds that of the traditional parallel plate MEMS variable capacitors. The MEMS tunable inductor is realized using MEMS fixed inductors, capacitors and a variable MEMS capacitor. The proposed MEMS multiport switch has demonstrated a superior RF performance up to 20 GHz. [C2909]

"Effects of electrostatic charge accumulation during MEMS fabrication"

Electrostatic charge transfer during the MEMS fabrication processes poses problems when the charge

accumulates on the MEMS device. This can cause both particle attraction to the charged micro-system or its components as well as malfunctions. An example of the effects of such phenomena is presented for the case of an electrostatic comb drive, where parts of the device are contaminated through electrostatic attraction (ESA). The results of the electrostatic field measurements performed during one fabrication process in MEMS devices are shown and a solution for overcoming the ESA effects is proposed. [C2910]

"Direct writing of self-assembled monolayers on gold coated substrates using a CW argon laser"

The ability to engineer surface properties such as hydrophobicity, charge, and adhesion at the micrometer scale is the key to developments in emerging technologies (e.g. bio-sensors, and barrier-free microfluidic systems). Development of a methodology to manipulate surface properties of a self-assembled monolayer of alkanethiol on a gold film was the objective of this paper. This system is broadly studied and widely believed to serve as the platform of choice to develop a variety of biological technologies. The proposed approach is unique in that it eliminates the need for photolithography, is non-contact, and can be extended to other systems such as SAMs on silicon wafers or polymeric substrates. For this study, an initial hydrophobic monolayer of 1-hexadecanethiol on a 300 E gold sputtered film is used. Localized regions are then desorbed in a nitrogen atmosphere by scanning the focal spot of a 488 nm CW Argon ion laser beam. The beam with a Gaussian spatial profile was scanned at a rate slower than the heat diffusion rate along the surface. After completing the scans, the sample is dipped into a dilute solution of 16-mercaptohexadecanoic acid and a hydrophilic monolayer self-assembles along the previously irradiated regions. The resultant lines are viewed by wetting with tridecane. [C2911]

"Quantum-dot cellular automata: computing by filed polarization"

As CMOS technology continue its monotonic shrink, computing with quantum dots remains a goal in nanotechnology research. Quantum-dot cellular automata (QCA) is a paradigm for low-power, high-speed, highly dense computing that could be realized in a variety of materials systems. Discussed here are the basic paradigm of QCA, materials systems in which QCA might be constructed, a series of experiments performed in the metal tunnel junction technology, and ideas for future QCA implementations. [C2912]

"Micro electron field emitter array with focus lenses for multi-electron beam lithography"

We report on the fabrication and characterization of a monolithic electron field emitter device with focus lenses for multi-electron beam lithography and high density nano data storage. An array of individually addressable emitters was formed on oxidized etch pits of an SOI (Silicon on Insulator) wafer. Si active layer of the SOI (Silicon on Insulator) wafer. Si active layer of the SOI with gate hole array that self-aligned with the emitters was used as a common gate electrode. An array of cylindrical holes formed on the Si base of the SOI was used as a common lens electrode. The emitters, gate and lens array components are isolated each other by 2 μm -thick thermal SiO₂ layers. For a single Pt emitter with gate hole of 2 μm diameter and anode voltage $V_{\text{anode}}=0.7$ kV, the emission current started at a gate voltage $V_g=90$ V and reached to 1.2 μA current and 0.84 mW beam power at $V_g=300$ V. The emission current was found to be stable with a fluctuation smaller than 10%/h. The emitter-gate and emitter-lens leak currents were found to be less than 1% compared with emission current. The focusing characteristic of the device was experimentally confirmed. A simulation work has shown that the beam with emission cone angle within 15° can be focused at a spot of 40 nm at a lens voltage, $V_{\text{lens}}=-6$ V. [C2913]

"Fabrication of a microfluidic device for axonal growth control"

A microfluidic device consisting of a hydrophobic passive microvalve and a nano-hole array used for release of axonal growth enhancement protein was fabricated and tested. The microvalve was constructed in a microchannel and driven by inlet pressure. The nano-hole array was fabricated in a SiO₂ diaphragm of 280 nm in thickness using FIB (Focused Ion Beam) etching. Each nano-hole measures 100-500 nm in diameter, and is smaller than the diameter of an axon terminal. Experiments using a fluorescent solution showed that chemicals were successfully being released through the nano-hole array and diffused onto the device surface for nerve cell culture. This result suggests that the fabricated device can make the NGF concentration gradient that is required to control axonal growth. [C2914]

"A highly reliable nano-clustering silica with low dielectric constant (k)"

A highly reliable nano-clustering silica (NCS) with low dielectric constant (k) [C2915]

"Silicon nitride trap memory with double tunnel junction"

It is shown that a novel SiN trap memory, which has double tunnel oxides separated by Si nano-crystalline layer, retains signal charge almost completely, keeping high-speed w/e in low w/e voltage. It is proposed that double

junction SiN memory with ultra-thin tunnel oxides and ultra-thin SiN is very promising for future memory. [C2916]

"GEPI: genetically engineered proteins for inorganics as molecular erectors in nanotechnology and bio-technology"

Controlled binding and assembly of proteins onto inorganics is at the core of biological materials science and engineering with wide ranging applications. Biological tissues are models for technological systems as they have excellent combination of physical and chemical properties due to their highly controlled surface chemistry, structures, dimensions and morphologies. A common denominator in all biological tissues is the presence of proteins, which may be enzymes, nucleators, habit modifiers, functional units, and scaffolds, and control intricate nano and microstructures of biocomposites hierarchically through specific biochemical interactions with other organic and inorganic structures. For developing truly biomimetic, reliable, and robust hybrid (inorganic/organic) materials systems for practical applications, we must use proteins that are designed, selected, or engineered to have specific affinity to functional inorganics. Using combinatorial biological techniques, i.e., phage display and cell-surface display, we isolate polypeptides (and further engineer them) with specific recognition elements for inorganic surfaces, including those not realized by natural proteins, in the absence of apriori prediction of necessary structures. We show that these Genetically Engineered Proteins for Inorganics (GEPI) are can be used as molecular erector sets for nanoassembly of functional materials including inorganics and synthetic polymers. The GEPIs could have significant potential applications by providing self-assembled functional molecular substrates in nano and biotechnologies. We hybridize GEPI with synthetic monomers that self-assemble onto selected substrates for nanoelectronics. We also demonstrate controlled, directed assembly of target molecules (protein or DNA) onto probes genetically fused to GEPI resulting in potential molecular substrates for utility in genomics and proteomics. Supported by a DURINT project through US-ARO. [C2917]

"Analysis of resistivity in nano-interconnect: full range (4.2-300 K) temperature characterization"

The characterisation of the damascene copper line resistivity as a function of linewidth and temperature were carried out for sub 100 nm feature size and down to 4.2 K. Mayadas model for grain boundary and sidewall scattering was used to analyse experimental data. The model is found to be in good agreement with experiment. The difficulty to isolate the different electron scattering mechanisms is highlighted. However. all the results show clearly that ITRS roadmap present requirement will not be respected in a close future. [C2918]

"Development of a three-dimensional electron microscope for stereoscopic observation of nano-structures"

Stereoscopic observation of nanostructures is one of the ultimate goals in the analytical technology field. Three-dimensional (3D) structures and elemental bonding states in the nanometer area affect the function and performance of new materials and advanced devices. Thus, their evaluation at high resolution and high accuracy becomes very important. We have developed a high performance 3D electron microscope solving those issues. The goals were a 3D resolution of 0.5 nm and an energy resolution of 0.5 eV in electron energy loss spectroscopy. Various technologies to achieve those goals were developed and integrated as a 3D electron microscope system. [C2919]

"Nano transformations: a future of our making"

"Nano" denotes the very small in scale, but there is nothing diminutive about the expectations generated by nanotech-the application of fundamental research at the nanoscale. [C2920]

"Few electron memories: finding the compromise between performance, variability and manufacturability at the nano-scale"

The key challenges for memories that operate at the nanoscale, and are compatible with mainstream nano-scale CMOS, are in achieving the performance characteristics that are useful at massive integration and in the reproducibility necessary for manufacturing. Use of single or few electrons, by utilizing the reduced dimensions-smaller number of states and larger charging energies-while appealing as a concept, needs to address the increased variance, smaller signal, and numerous other consequences of reduced collective phenomena. Several key ideas of recent times, from the use of nanocrystals to defects and decoupling of storage from the read process, provide paths where power, speed, technology compatibility, and variability is addressed. This paper discusses several of these approaches and their attributes, focusing on finding the design compromises for usability and manufacturability. [C2921]

"Molecular dynamics study on double wall carbon nano tube for nano mechanical manipulation"

In this paper, we study the on the mechanical property about the manipulation of the inner tube in DWNT's by a molecular dynamics simulation based on Van der Waals force for mutual interaction between inner and outer tubes. [C2922]

"Development of vacuum environment compatible nano-probe system"

In VLSI manufacturing, increase in the level of integration and functional improvement are essential. In order to achieve these objectives, semiconductor manufacturers are beginning to establish sub-0.1 μm micro fabrication technologies. On the other hand, it is also necessary to compose the electrodes for operation tests of the VLSI. However, the size of electrodes available for such applications are currently on the order of 50×50 - $100 \times 100 \mu\text{m}$, which is a serious problem which must be overcome to accomplish the above-mentioned improvements in VLSI manufacturing. We have developed a new probe of which the tip diameter is 1 μm or less. Also, we have succeeded in developing a new system that incorporates four sets of manipulators, which can accommodate the new probe and direct it to a desired location by observation with high resolution using a SEM (Scanning Electron Microscope). [C2923]

"Application of ozone ashing dry technology in the fabrication of mesoporous silica film with ultra-low dielectric constant and high mechanical stability"

Ozone ashing dry technology has been applied in the fabrication of mesoporous silica film with ultra-low dielectric constant. The process removes the organic template efficiently at relatively low temperature. The film has an ordered pore structure and uniform pore diameter, which lead to a good mechanical strength and better electrical reliability. [C2924]

"A MEMS based interposer for nano-wafer level packaging test"

We have developed a novel MEMS based interposer which serves as the electromechanical interface between the device chip under test (DUT), and the test processor. It is capable of fanning out of 100 μm pitch I/Os to 750 μm pitch pads which is compatible with conventional PCB technology. The interposer has both power and ground planes near the signal traces to enable the high frequency transmission. It was fabricated on a silicon substrate using semiconductor and micro-machining processes. Through wafer vias were formed by KOH anisotropic etching. Conductive materials were filled in the vias to form interconnection. The interposer also has compliant structures which give vertical compliance to the probe pads. Because silicon substrate is used, there is no thermal mismatch, which gives our interposer the potential of being used in wafer level burn-in test. [C2925]

"Combining DIC techniques and finite element analysis for reliability assessment on micro and nano scale"

Recent development of new electronics and microsystem devices, including 3D integration, ultra thin chips, polymer electronics, high temperature electronics and MEMS/NEMS packaging, call for thermo-mechanical material and component characterization for reliability assessment on micro and even on nano scale. Both Finite Element Analysis (FEA) and deformation measurement are increasingly insufficient tools for that purpose as long as they are utilized as stand alone methods. The paper presents conceptual issues how to combine these two tools to make them a more powerful hybrid method. The applied by the authors digital image correlation method (DIC) for deformation measurement on micro and nano scale is briefly introduced. Emphasis is made on measurements based on AFM scans. Subsequently, application examples are referred to, e.g. for microcrack evaluation by combined DIC/FEA analysis as well as for the study of low cycle fatigue behavior of solder balls on BGAs. [C2926]

"Ambient intelligence visions and achievements: linking abstract ideas to real-world concepts"

The ambient intelligence vision is abstract and as such not useful for funding decisions, research project definition, and business plan development. This is in particular the case for the electronic design community. The European Commission intends for the EU to achieve world leadership in Information Societies technologies within ten years. To that end, it has incorporated the ambient intelligence vision in its Sixth Framework. Microelectronics and nano- and optical devices are seen as key technologies. Interesting chip-level challenges are found in, amongst others, explicit modeling of mobility and self-management, and novel computing substrates, based on electronic textiles or organic electronics. [C2927]

"A 65 nm CMOS technology with a high-performance and low-leakage transistor, a 0.55 μm^2 6T-SRAM cell and robust hybrid-ULK/Cu interconnects for mobile multimedia applications"

This paper presents a 65 nm CMOS technology for mobile multimedia applications. The reduction of interconnect capacitance is essential for high-speed data transmission and small power consumption for mobile core chips. We have chosen a hybrid ULK structure which consists of NCS (nano-clustering silica; $k=2.25$) at the wire level and SiOC ($k=2.9$) at the via level. Although NCS is a porous material, the NCS/SiOC structure has sufficient mechanical strength to endure CMP pressure and wire bonding. Successfully fabricated 200 nm-pitch hybrid-ULK/Cu interconnects and a high-performance and low-leakage transistors meet the electrical targets from the circuit requirements. Moreover, an embedded 6T-SRAM with a 0.55 μm^2 small cell size has been achieved.

[C2928]

"Ultra-high density board technology for sub-100 μm pitch nano-wafer level packaging"

As microsystems continue to move towards higher speed and microminiaturization, the demand for interconnection density both on the IC and the package increases tremendously. With the shift towards nano ICs by 2004 with [C2929]

"Sol-gel derived and repairable nano-interconnects"

Most of the compliant interconnects that are currently being developed have inductance and resistance higher than desirable. There is definitive evidence that nano-structured interconnects can provide better resistance to crack growth and fatigue resistance and hence improve mechanical reliability without sacrificing the electrical properties. Current approaches to interconnects such as reflowed solder paste and electroplated interconnects cannot easily achieve nano-grained structures and also impose restrictions on the processability. For example, screen-printing solder pastes cannot achieve very fine pitches, while electroplated interconnects are restricted to a few material systems. The current wafer level packages are at a pitch of 250-400 microns. We propose solution derived reworkable nano-interconnects as a viable technology to meet the needs of reducing pitch in the die package. This paper proposes solution derived (sol-gel based) nano-grained copper and lead free solders for fine-pitch high strength nano-structured interconnects. In this process, metal-based organic polymer solutions are heat-treated in reducing atmosphere to form metallic copper and lead-free solders (Sn-Ag-Cu). The key is to achieve ultra homogeneous mixing at atomic to molecular level. The precursors were mixed in solvent and refluxed under inert atmosphere at 125°C to form metallic Cu/Sn-Ag-Cu complex solutions. The homogenous gel obtained from the hydrolysis of sol-gel precursor solution is heat treated under inert atmosphere at temperatures below 350°C to achieve the desired compositions. Among a large number of methods for metal deposition, sol-gel technology, based on thermal decomposition of metal-organic compounds, can prove to be the most convenient and inexpensive for industrial applications. [C2930]

"Application of electron-beam illuminated low-k silicate to nanoscale interconnect technology"

In this paper, a direct patterning technology of non-photosensitive silicate based hydrogen silsesquioxane was investigated with electron beam lithography for IMD applications. [C2931]

"Impacts of hole trapping on the NBTI degradation and recovery in PMOS devices"

In this paper, impacts of hole trapping on the negative bias temperature instability (NBTI) degradation and recovery in PMOS devices was investigated. Dual-gate p- and n-channel MOSFETs were fabricated using a standard CMOS twin-well technology. [C2932]

"Anisotropic thermal conductivity of nano-porous silica film"

In this work thermal conductivity of porous silica film was studied comprehensively. Silica films with porosity from 21% to 64% were spin coated. It is observed for the first time that the porous silica material has strong anisotropic characteristic. The pores in the higher porosity silica film tend to distribute horizontally. This distribution of the pores in the dielectric film is the main factor that induces the anisotropic characteristic. We proposed a serial-parallel hybrid model to explain the correlation between porosity and thermal conductivity in both in-plane and cross-plane components. The anisotropic characteristic of the thermal conductivity may be accompanied by the anisotropic dielectric constant, which will greatly complicate the RC delay simulation of the circuits. [C2933]

"PRESENCE: the sense of believability of inaccessible worlds"

With the development of communication methods and devices, it became possible to perform actions more and more distant from the task spaces. These new tools raise today the question of Presence of distant spaces with a growing accuracy. In a first part, we show that the distance between the manipulation space and the task space, in a teleoperation activity, points to different meanings. However, the same need for a strong Presence of

the task space raises, whatever the distance between these spaces is. We then discuss the notion of Presence as a cross-point between technological and scientific disciplines, and propose some general idea that may reinforce it. In a second part, we illustrate the previous ideas with the example of manipulation of nano-objects. We show how it is possible to enhance dramatically the feeling of Presence of the nano-objects to be perceived and manipulated, by adding haptic bi-directional transducers to the visual and acoustical sensors used today. By the end, we defend the idea that the feeling of Being there is deeply dependent on multisensoriality. [C2934]

"Regressive testing for system-on-chip with unknown-good-yield"

This paper presents a testing method for electronic devices with no a-priori yield information. This problem is referred to as the unknown-good-yield (UKGY) problem. The UKGY problem of systems-on-chip (SoC) is discussed in this paper as SoCs are in general built with embedded intellectual property (IP) cores, each of which is procured from IP providers with no information on known-good-yield (KGY). In general, partial testing is a practical choice for assuring the yield of the product under the stringent time-to-market requirement in today's high density/complexity electronic devices such as SoCs built with deep submicron or nano technology. Therefore, an efficient and effective sampling technique is a key to the success of high confidence testing. An experimental characterization-based testing (referred to as ET) method for SoC has been proposed prior to this work, in which a stratified sampling method was employed based on environmental-based characterization and an experimental design technique to enhance the confidence level of the estimation of yield. The proposed testing method, referred to as regressive testing (RegT), in this paper exploits another method by using parameters (referred to as assistant variables (AV)) free from UKGY that determines the criteria to sample and test SoCs, and employs the regression analysis method to evaluate the yield with regard to confidence interval. A numerical simulation is conducted to demonstrate the efficiency and effectiveness of the proposed RegT in comparison with generic random testing method. [C2935]

"A memory built-in self-repair for high defect densities based on error polarities"

This paper presents the architecture of a new memory built-in self-repair approach targeting memories affected by high defect densities (several orders of magnitude higher than in current technologies). Such a repair scheme is suitable for building memories in nano-technologies, which are subject to very high defect densities. The new approach allows combining two defective units to create a fault-free unit. For making this combination possible, the approach analyses the polarities of the errors produced by the faulty units of the memory, and combines units producing the same error polarities. The combination is done by means of functions that mask the errors of a particular polarity. [C2936]

"Nano, quantum, and molecular computing: are we ready for the validation and test challenges?"

In the recent years a lot of research effort is being spent in the areas of nanotechnology, quantum computation, and biologically inspired computing. As we are faced with various challenges regarding their implementability, architectural visions, and design automation, not much has been done in the field of high level design and validation in looking further into the future, and ponder about the state of the art in design validation and test in such miniscule technology era. Very few reported research work have surfaced on the design and validation challenges for these technologies. However, this certainly is a matter of concern because the technology of the small will be ridden with random faults and hence architectural design strategies need to change to take into account these stochastic models of failures to build robust designs. Validation of such designs also have to capture the stochastic behavioral models of the technology, and hence traditional validation and testing techniques will not work directly. Are we getting ready with our theory; technology and tools to address these challenges? This futuristic panel asks technology and computer aided design experts, as well as finding agency program managers questions about the technological barriers to be surpassed, as well as how the funding agencies such as NSF are ramping up for this technological future. [C2937]

"Overview of nanotechnology and TND in Korea"

The author reviews progress in the Korean Government plan to develop nanotechnology in the country. The plan focuses on the selected areas that are related with the most commercial potential and the competitiveness over advanced countries. The promising fields are nanodevices, nanomaterials, nano-processing and basic technologies. The government expects the plan to produce at least 10 cutting-edge NTs and to produce 12,600 NT experts by 2010. [C2938]

"Electrical resistivity evaluation of air-wiring formed in nano-space by focused-ion-beam chemical vapor deposition"

In this paper, we report fabrication and electrical evaluation of various air-wirings formed by FIB-CVD. The FIB

system utilizing a beam of 30 keV Ga⁺ ion was applied to make air-wiring. We fabricated two kinds of air-wirings. One was fabricated using two phenanthrene (C₁₄H₁₀) source gases. The other was fabricated using a mixture gas of tungsten carbonyl (W(CO)₆) and C₁₄H₁₀ source gases. Then the electrical resistivities were compared. [C2939]

"Graphitized wavy traces of iron particles observed in amorphous carbon nano-pillars"

We found that traces of iron nano-particles were graphitized in amorphous carbon nano-pillars fabricated by electron beam induced chemical vapor deposition (EB-CVD). The random walk of iron particle in the carbon nano-pillar caused the continued growth of wavy graphite tube just after the iron particle passed by, as a result of vacuum annealing at 800 C for 30 minutes. The origin of the iron nano-particle was the decomposed ferrocene basement for the carbon nano-pillar. The size of the amorphous carbon nano-pillar was controlled to have the minimum diameter of 5 nm by adjusting the electron current and supplement of the source gas. This small feature size of the nano-pillar strongly restricted the area for the movement of the iron particle, and thus the graphitized trajectory of the iron particle was revealed on a TEM image. [C2940]

"New digital circuit techniques for total standby leakage reduction in nano-scale SOI technology"

This paper proposes two novel circuit techniques, one each for static and dynamic logic, for ultra-low standby sub-threshold and gate leakage power in future fully-depleted SOI technology. The proposed schemes make intelligent use/combination of SOI dual-VTH transistors, supplementary capacitors, forced stacking and VTH-wave-pipelining techniques to reduce power in standby mode and maintain/improve active-mode circuit speed. An analytical formula for optimum transistor sizing in the proposed dynamic logic scheme is derived and validated. It is demonstrated that the proposed schemes become very attractive for wide datapath designs in future aggressively scaled SOI technology. [C2941]

"Micromanipulation-as an assembly tool for three-dimensional photonic crystals"

One of the desired applications of photonic crystals is an optical integrated circuit which is equivalent to a highly integrated circuit of an electronic device. Electronic devices have adopted a three-dimensional (3D) arrangement of elements and wiring in order to formulate highly integrated components. To bring a similar success of the present electronic devices to the field of optoelectronics, the development of fabrication technologies of 3D photonic crystals must be undertaken. If all the waveguides and elements are supposed to be arranged in one 2D plane, high integration cannot be desired; waveguides will become unnecessarily long and complicated. Furthermore, realization of integrated optical circuits means that we need to be able to lay out elements made of various materials suitable to each purpose at exact positions as we designed, and connect them with intricate waveguides. The materials of the crystals are supposed to be semiconductors if we want to add active elements such as lasers and LEDs. There have been no technologies which fulfill all these requirements. Recently we have introduced a novel fabrication technology for a semiconductor 3D photonic crystal by uniting integrated circuit (IC) processing technology with micromanipulation. Four- to twenty-layered (five periods) crystals for infrared wavelength (3-4.5 micrometer) were integrated at predetermined positions on a chip with a structural error of within 50 nm. Observation of the PBG confirmed the precision of our technique. A crystal with a controlled defect was also arranged on the same chip. Numerical calculations revealed that a transmission peak observed at the upper frequency edge of the bandgap originated from the excitation of a resonant guided mode in the defective layers. This technology offers immense potential in becoming a breakthrough in the production of optical wavelength photonic crystal device. In the field of photonic crystals, our method is considered as a very eccentric approach. However, when we widely overlook the industrial production lines, it turns out that manipulation technique has already deeply taken in the field. For example, mass production of the high-density mounting circuits for mobile computing products are enabled by a manipulation robot's ultra high-speed assembly based on image recognition. In the case of photonic crystal devices, things are not easy as the case of electronic devices, because assembly in the micro world is quite different from what we experience in the macroscopic scale; surface effects and electrostatic force rule over more strongly than inertia. Moreover, part size and accuracy required for photonic crystals are about 1000 times smaller in scale of that required in electronic products. Because of these difficulties, an operator operates micromanipulation system to assemble elements one by one for now, thus not a few people claim that our technique is just a toy for research. However, if the systems for image recognition and feedback in micro and nano scales are established, mass production of photonic crystal devices by automatic manipulation is not a dream. Also the technology which can perform stable assembly in these scales is indispensable not only to the field of photonic crystal device but to the field of the electron device and micromachining in which miniaturization is progressing at an increasing speed. [C2942]

"Digest of Papers Microprocesses and Nanotechnology 2003. 2003 International Microprocesses"

and Nanotechnology Conference"

First Page of the Article [C2943]

"Low temperature sintering process for deposition of nano-structured metal for nano IC packaging"

This paper presents the study of some nano-sized metal powders, and the processes of depositing these on silicon wafers, for use in nano-structured wafer level interconnects. Nano-powders, 50-100 nm, of copper and silver, obtained by electro-explosion of the metal wire, are used in this study. Pastes were obtained by suspension of the nano metallic powder in surfactants, organic carriers and reducing agents. The pastes were printed onto surface-treated silicon wafers and sintered at around 400°C. Results show that there is a potential of lowering the sintering temperature to 200°C, which would be more ideal for microelectronics applications.

[C2944]

"AtmoCube: observation of the Earth atmosphere from the space to study "space weather" effects"

AtmoCube represents an innovative measurement system for the study of the Earth atmosphere starting from altitude of the order of 600 km. It appears as a cubic nano-satellite that has dimensions of 10x10x10 cm³ with a total weight of 1 kg (aluminium structure). The main scientific instrument is a spectral dosimeter-radiometer allowing continuous monitoring of the radiation environment. The payload includes also a magnetometer belonging to the passive stabilization system. A GPS (Global Positioning System) provides a continuous measurement of the satellite position and allows us to build a map of the measured atmospheric parameters. The goal is to build a precise map of the Earth's magnetic field and of the flux of radiation impinging on the instrument, which is related to space weather effects. The GPS, providing the position of the region where the measurements are performed and the corresponding time instant, allows us to correlate these measurements with other measurements performed on Earth and from space and therefore with the indexes of the solar activity. In addition the GPS allows an indirect measurement of the atmospheric density. It has been decided to use an international platform, CubeSat, a "quasi standard" structure that allows to start from a well consolidated basis. CubeSat is an international program and network that has educative purposes and is already in the production phase in the United States and in Japan. In Norway and Germany the program has started. With AtmoCube, Italy can become an active member of the CubeSat network. [C2945]

"Autonomous target ranging techniques"

For the deep space asteroid mission, Bering, the main goal is the detection and tracking of near Earth objects (NEOs) and asteroids. One of the key science instruments is the 0.3-m telescope used for imaging and tracking of the detected asteroidal objects. For efficient use of the observation time of this telescope, a fast determination of the range to and the motion of the detected targets are important. This is needed in order to prepare the future observation strategy for each target, i.e. when is the closest approach where imaging will be optimal. In order to quickly obtain such a determination two ranging strategies are presented. One is an improved laser ranger with an effective range with non-cooperative targets of at least 10,000 km, demonstrated in ground tests. The accuracy of the laser ranging will be approximately 1 m. The laser ranger may furthermore be used for trajectory determination of nano-gravity probes, which will perform direct mass measurements of selected targets. The other is triangulation from two spacecraft. For this method it is important to distinguish between detection and tracking range, which will be different for Bering since different instruments are used for detection and tracking. Also, the baseline distance between the two spacecraft will provide two different (close and far) scenarios of observation. The limiting range and the relative range accuracies of the triangulation method are discussed. [C2946]

"Absorption of the Cr(VI), Hg(II), As (III) ions with the Al/sub 2/O/sub 3/ nano-powder from the water"

Compounds of mercury, chrome and arsenic are very dangerous to man due to their instability and their interaction with fats, providing long periods of partial ejection, i. e. the time during which half of the agent assimilated with the organism ejects or destructs. Hence, the control of mercury, chrome and arsenic content in the water is very critical. In this paper, the sorption capabilities of the nano-powders of aluminum oxide and aluminum hydroxide of the class "HCh" annealed at the temperature 450 degC with respect to Hg (II), As (III), Cr (VI) for water purification are examined. [C2947]

"Characterization and modeling of SOI varactors at various temperatures"

SOI varactors have attracted attention for RF circuit applications due to the superior speed advantage of SOI technology. This paper presents the capacitance and the quality factor of MOS varactors in SOI CMOS process

at various temperatures. The temperature coefficient of capacitance of inversion-mode device is larger than that of accumulation-mode devices in the normal operating range. Besides, the quality factor decreases with increasing temperature for these varactors. A device model based on BSIM3v3 model is proposed to simulate the temperature effect. The modeled results of the capacitance, series resistance and quality factor for SOI varactors have excellent agreement with the measured results. [C2948]

"Influence of visco-elasticity of low-k dielectrics on thermo-mechanical behavior of dual damascene process"

For backend processes, thermo-mechanical failure is one of the major failure modes. A representative metal structure in a Cu/low-k dual damascene process is examined, considering the major thermal loads and process steps through combined finite element simulation with experiments. Firstly, the low-k material, in our case the polymeric material SiLK (trade name of the Dow Chemical Company) is characterized and modeled to provide a reliable material model and data for the simulations. Characterization measurements (nano-indentation-creep test) are carried out on a polymer film deposited on a substrate. Here a quasi-elastic approach is used to account for the substrate influence and the time dependency acting at the same time. Elastic indentation curves are simulated with a varying modulus of the film within an expected interval. The coefficients for a Maxwell relaxation model are calculated, and verified through FEM simulations. Furthermore results of temperature dependency and influence on the modulus are examined and the WLF coefficients are calculated providing time and temperature dependent material parameters for the process simulations. The main dual damascene process steps are simulated using the obtained material model. Stresses are examined at different critical locations. Furthermore an initial defect is placed at a low-k-oxide interface, where energy release rates are determined. Our results show that Cu/low-k structures exhibit significantly different reliability characteristics than their aluminum predecessors, which are more critical from several design aspects. This not only makes the stress management in the stacks more difficult, but also strongly impacts packaging. [C2949]

"New European concept of single staged rocket to launch nano-satellites in low earth orbit (LEO)"

The possibility to launch small payloads into LEO by means of an electromagnetic railgun is the motivation of the present study. Here it is assumed that an electromagnetic railgun with barrel length of 180 m is able to launch a 120 mm diameter projectile at a speed of 6 km/s. In order to the payload achieves orbital motion and to compensate the velocity losses due to gravity and aerodynamic drag, a rocket engine which supplies the required velocity difference is integrated into the projectile structure. The development of such propelled projectile requires key technologies that could also benefit other industrial sectors. The paper presents the main concept and design aspects to be considered for such propelled projectile with special emphasis on: flight mechanics, aero/thermodynamics, materials and propulsion characteristics. The aerodynamic form of the projectile is optimized to achieve minimum drag and lower heat loads. Launch angles and trajectory optimization analysis are carried out by means of 3 degree of freedom simulations (3DOF). Furthermore, three concurrent propulsions systems are here considered for the rocket engine: solid, liquid and hybrid propellants type. The result of analysis pointed that the most promising propulsion systems are: (I) hybrid engine based on hydrogen peroxide/wax propellants and (II) liquid engine based on hydrogen peroxide/hydrocarbon propellants. The structural mass is analyzed mostly on the basis of carbon fiber reinforced materials as well as classical aerospace metallic in small amount. Finally, the paper gives a critical mark for the technical feasibility of small rockets for such missions. [C2950]

"Microstructure of spark-plasma sintered TiB₂-Cu nanocomposites"

The goal of this study is to investigate the evolution of microstructure of TiB₂-60 wt.% Cu nanocomposite and titanium diboride nanoparticles behavior during spark-plasma sintering. One of the current problems facing material science is the production of bulk materials with fine nano-level microstructure. Methods of mechanical alloying and mechanical treatment are widespread and well known for making it possible producing a great variety of composite powders with nano-level grains or inclusions. Ti-B-Cu powder mixtures were mechanically treated in high-energy planetary ball mill AGO-2 with stainless steel balls and vials. Balls of 5 mm diameter were used. The powder/balls weight ratio was 1/20 in all experiments. Before milling the vials were pumped and filled with argon to prevent oxidation during processing. To study the connectivity between TiB₂ particles we removed copper matrix from the surface of SPS-compacts by electrochemical etching and formed a layer. X-ray phase analysis shows that this layer consists of titanium diboride as the major phase with small amounts of TiBO₃ probably formed as a result of electrochemical reaction. [C2951]

"Computer simulation of electromagnetic transmission through perfectly conducting plate with subwavelength apertures"

The study of electromagnetic transmission through a metallic plate with apertures has been investigated for a long time. However, it is one of the important current issues in optics. The small aperture of a metal-coated probe makes possible high resolution beyond the refraction limit (Ohtsu, M. and Hori, H., "Near-field Nano-optics: From Basic Principles to Nano-Fabrication and Nano-Photonics", Kluwer Academic Plenum Publishers, 1999). The extraordinary enhancement of the optical transmission through subwavelength apertures in metal films has been observed (Ebbesen, T.W. et al., Nature, vol.391, p.667-9, 1998). We perform computer simulations of the electromagnetic transmission through a perfectly conducting plate, which has infinite area, with subwavelength apertures. The surface integral equation method is employed to perform the computer simulation. The apertures which are parallel to the incident electric field have more influence on the field distributions than the apertures which are perpendicular to the incident electric field. [C2952]

"Interconnect and packaging for applications on the cutting edge"

Interconnections and packaging structures are a dominant design consideration of many dimensionally- and performance-constrained systems. The growth in interconnect and its effect on system and packaging evolution are discussed, and recent work and future directions in packaging are discussed. The power-law relationship between input/output terminals is used in part to explain a number of these trends, including 3-D packaging, system-in-package, and potential nano-scale interconnection. In complex systems involving a mixture of component types, the goals of ultimate density and performance unfortunately compete with objectives of modularity and serviceability, so difficult systems design decisions must be confronted. The trends in thermal management drive more aggressive schemes, though these solutions must combat the needs for compatibility with infrastructure and cost effectiveness. [C2953]

"Obtaining and properties of the copper nano-dimensional powders"

This paper investigates the properties of the nanopowders obtained by the electrical explosion of the metallic conductors (EEMC) to determine the influence of chemically active atmosphere on the properties of Cu powder. To investigate the active gas influence on the structure of the formed nano-powders, the general photos of the powders in different atmospheres were obtained. We concluded that with Cu EEMC in active atmosphere, an increase of the contribution of the diffusion-limited agglomeration in the mechanism of the formation growth of fractal structures occurs. Lastly, it was established that with Cu EEMC in CO₂ and N₂ a decrease of the aggregates average number and an increase of the agglomerates average number occur. [C2954]

"Thermal annealing action on plastic deformation of submicrocrystalline alpha-iron"

The unique physical and chemical, mechanical properties of nano- and submicrocrystalline materials are due to such factors as the small size of grains, defective structure of the grains boundaries, high level of the internal stresses, microstrainings of crystal lattice, and high density of grain-boundary dislocations. This paper considers the structure, mechanical characteristics and the peculiarities of plastic flow of SMC Armco-iron subjected to thermal annealing at different temperatures. Structural investigations were performed by the methods of translucent electron microscopy (TEM). Investigation of straining relief showed that regardless of the mode and the quantity of passages in even-channel angular pressing the samples of SMC alpha-Fe have high tendency to the straining localization. Mechanical properties of the investigated samples are determined by the mode of ECAP. Thermal annealing of the samples of SMC alpha-Fe allows one to change their mechanical characteristics within wide ranges. [C2955]

"Structure and properties of nano-structural composite material CU-0.56 R% ZrO/sub 2/"

Advances in the methods for studying the plastic deformation in volumetric nanostructural materials have been made in recent years. With the usage of the particles tolerance of strengthening phase with low dissolution in matrix and high particles tolerance to the coagulation processes, one can expect that nano-structural composite material can have not only high strength but also high stability of the structural and phase state to external temperature and temperature-force affects. In the given paper, one considers high-energy method of obtaining composite powders of copper and the methods of intensive thermal and force affect for their compacting and obtaining porousless composite materials. Mechanical properties were determined with the tension under normal conditions by means of the installation of IMASH. Thus, experimental investigations showed that the complex method of high-energy mixing the copper powder with nano-dimensional particles of oxides in attritor, compacting, annealing the obtained powder following by the intensive thermal force treatment allows one to obtain composite nano-structural material with uniform distribution of the second phase particles. [C2956]

"Design and simulation of MEMS optical crossconnect with integrated nanophotonic crystals technology"

Evolving optical transport networks of wavelength-division-multiplexed (WDM) systems has lead to rapid growth in demand for functions inside the optical layer to manipulate traffic on the wavelength basis. In this paper, a novel method to make in-plane reactive-ion-etching (RIE) micro-electro-mechanical systems (MEMS) optical switch devices in optical communication easier and better is explored, through nano fabrication technology, with the integration of nano photonic-bandgap (PBG) crystal waveguides to improve the performance of MEMS optical-cross-connects (OXC). [C2957]

"Silicon nano-devices and single-electron devices"

Recent progress in CMOS LSI fabrication technology made possible to achieve nanometre-size silicon device. The devices should operate with CMOS transistors to efficiently use high sophisticated CMOS technologies. To achieve high functionality, especially using silicon as a base the difficulty arises in making the coherent length sufficiently longer than the device size. Another candidate is a single-electron transistor (SET), which does not use coherency. The device manipulates a single electron by means of a Coulomb blockade. Fabricating SETs using Si MOS process has been useful in overcoming because SETs were combined with MOSFET. This allows to emphasize the special functionality of SETs like multiple-valued operation, and high voltage gain. [C2958]

"Control challenges in micro fluidic systems and nanoscale transport phenomena"

Over the last three decades, the number of available micro devices, actuators, and sensors has grown in leaps and bounds. Moreover, newly emerging nano-technology and nano-sized patterning techniques are enabling even more capabilities in micro fluidic systems. The micro community is now moving from component creation to system design, optimization, and control. Hence there is a real opportunity for control researchers, who are well versed in system dynamics and control, to contribute to the maturing field of micro systems, and also to the emerging field of nano systems. This paper presents some brief examples of our research efforts in this direction, and outlines our perspective on the available control opportunities and emerging system integration and control challenges. [C2959]

"Wavelength division multiplexing for 1.3 and 1.55 micron by photonic crystal directional couplers"

In this study, we report the photonic crystal directional couplers to separate the wavelengths for 1.3 and 1.55 μm . The extinction ratios of the output ports for 1.3 and 1.55 μm are around 10 dB. This structure can be used to realize the photonic crystal nano-detection system for wavelength division multiplexing purpose. [C2960]

"Ultra-fine pitch Pb-free & eutectic solder bumping with fine particle size solder paste for nano packaging"

With the demand for electronic component miniaturization with high functionality, high density assemblies requires finer interconnect features and pitches, which cannot be met using conventional solder paste screen printing. Ultra-fine pitch solder deposition can be carried out by electroplating but with related cost and environmental issues. This paper discusses a feasible deposition process for ultra-fine pitch using fine particle size solder pastes. Two types of pastes of differing particle sizes, each with lead-free SnAgCu and eutectic SnPb compositions are compared. 50 pin bumps at 100 μm pitch are deposited via paste printing through a photo-sensitive polymer mask which is strippable after solder reflow. Printing was carried out on a whole wafer with depopulated and full array die with around 4000 I/Os per die as test vehicle. The test vehicle consisted of BCB passivation and under bump metallization (UBM) on aluminum pad. The processability of the pastes is compared. Good bump height uniformity is found where difference observed between the paste types is briefed. Due to the fine particle size of these solder pastes, the possible oxidation of the bumps after reflow is examined. The implications of reduced solder bump volumes and cross-sectional area of the UBM-to-solder joint on bump shear strengths and failure mechanisms are analyzed. Also discussed are the micro structural evolutions of the bumps after reflow, where differences are observed between the types of solder pastes and compositions. [C2961]

"Assembly process modeling for flip chip on flex interconnections with non-conductive adhesive"

This paper presents a comprehensive methodology to model the assembly process of flip chip on flex interconnections with non-conductive adhesive (NCA). The methodology combines experimental techniques for material characterization, finite element modeling and model validation. The non-conductive adhesive material has been characterized using several techniques. A unique experimental technique has been developed to measure the cure force. A 2-D axisymmetric finite element model is used for analysis of flip chip on flex package with nonconductive adhesive, which takes into account assembly force, cure shrinkage, adhesive modulus buildup, removal of assembly force and cooling down to room temperature. The relationship between the contact

pressure obtained from finite element simulation and the measured bump contact resistance has been established through the development of a dedicated experimental setup, which uses a microforce-tester combined with a digital multimeter and nano-voltmeter. The process modeling has been validated by comparing the predicted contact resistance value and the measured contact resistance value after assembly process. The approach developed in this paper can be used to provide guidelines with respect to adhesive material properties, assembly process parameters and good reliability performances. [C2962]

"Slow-wave characteristics of interconnects on silicon substrates"

This paper deals with slow-wave characteristics of interconnects on silicon substrates. In slow-wave mechanism, the microstrip lines with and without bottom-shielded ground structures (MIM structures and MIS structures) are characterized. Slow wave propagation in MIS structure occurs when the operation frequency is not so high and the substrate resistivity is moderate, effective permittivity increases and the propagation velocity slows down due to Maxwell-Wagner mechanism. The transmission line parameters such as series resistances and inductances are calculated as the function of frequency. Results shows that the silicon substrate of the non-shielded transmission line can be treated as imperfect ground plane and called as skin-effect mode. [C2963]

"The key technologies of performance optimization for nanometer routing"

Routing plays an important role in VLSI/ULSI physical design. It is useful to develop advanced and efficient routers. The main nano challenge to routing is to perform "rigorous" performance optimization. The shrinking of geometry brings great concerns for chip performance. Interconnect effects cause longer delay. The decreasing of interconnect spacing has made the inter-wire coupling capacitance the dominant part of load capacitance, which causes longer delay and coupling noise (crosstalk). This paper discusses the key technologies of performance optimization for nanometer routing. One is the interconnect optimization, which includes delay/noise modeling and interconnect architecture. The other is the performance optimization for all nets routing, which focuses on multi-constraints optimization and multi-level optimization. [C2964]

"Micro cantilever probe array with integration of electro-thermal nano tip and piezoresistive sensor"

A micro cantilever-lip silicon probe-array with integrated electro-thermal nano-lip and piezoresistive sensor has been presented for NEMS high-density data storage. Such a 1410 probe-array is designed after the working principle studied. Both analysis and FEM simulation are used for modeling and designing with their results agreeing well, with a tolerance of only 5%. The devices are fabricated by using silicon bulk micromachining technology. The relationship between the resistance of the heater and the temperature of the tip is experimentally obtained and fitted with second order polynomial function. With the fitted results, the pulse-heating property of the devices is characterized. The tested results are in agreement with the simulation. Under pulsed 4V power supply and 3 μ s heating period, the tip can be heated to 463.15 K. Near 100 KHz writing rate can be realized, as 6.2 μ s is needed for cooling the heating resistor. The sensitivity of piezoresistivity is 5.4410-4 under the contact force of 2410-7N, which is sufficient to reading the data pitch on PMMA media. [C2965]

"Micromachined on-chip vacuum microtriodes with nanotube field emitters"

Miniaturized power-amplifying vacuum devices in an on-chip form have been constructed by combining high performance nanomaterials with MEMS micromachining technology. Carbon nanotubes, one of the most fascinating new nano-materials, were incorporated into micromachined designs as cold cathode field emitters to create MEMS triode structured power amplifiers. Microstructure of the nanotube was characterised by SEM micrograph. MEMS device applications, design parameters, and device functions were discussed. [C2966]

"Drivers for nanotechnologies in Europe"

Drivers for nanotechnology, drivers for innovation, drivers for economic growth. Many people say that the key to anticipating future growth is to first understand the underlying motivation for current trends today. According to this belief, by drawing a line from the past to the present, we are able to predict the future by extrapolation. The now infamous Moore's law is an example of this endless march down the road of technology development. For many years now scientists have been predicting that modern IC production technology has finally reached a limit, some sort of brick wall beyond which Moore's law can no longer hold true. But, keeping in-line with Moore's law, entering the nano-era requires an increasingly significant effort in research and development. The emergence of bottom-up approach to fabrication of structures requires the integration of competencies from many different fields of expertise. Assembling devices one molecule at a time using molecular building blocks requires a skill set not typically found in a traditional semiconductor environment. The new breakthrough technologies will likely result from the integration of applied microelectronics background with more fundamental inputs. And for this, Europe again has specific strengths due to the synergy between national and European level initiatives. [C2967]

"Self-organized iron silicide nano dots on silicon [C001] substrate"

This paper studies the self-organized iron silicide nano dots on silicon [001] substrate. In the experiment, self-aligned (1D) iron disilicide quantum dots have been successfully grown by a UHV electron gun evaporation system with vacuum level better than 10^{-9} torr, using either SixGe1-x or strained Si as a substrate. JEOL 2010 and 4000EX transmission electron microscopes, operating at 200 and 400 KeV, were used to study the microstructures. [C2968]

"Optical-gradient type of antireflective coatings for sub-70 nm optical lithography applications"

We demonstrate an optical-gradient bottom antireflective coating film, which is prepared by a silicon nitride film treated with oxygen plasma. Results indicate that the optical-gradient type film is suitable for sub-70 nm optical lithography applications. [C2969]

"Manipulation of the universal rotational mechanism for biological application"

Recently, in the potential application of biological and micro-nano technology, there are increasing demands in areas such as bio-cell manipulation and micro fabrication at the micron or nano scale. However, it is very difficult to carry out direct micro manipulations. In contrast to microscopic working procedures, which permit free manipulation of objects with the both hands, microscopic working procedures that permit free manipulation of objects with the both hands, microscopic working procedures involve the observation and manipulation of the object within a very small area under a scanning electron microscope. We are currently developing a manipulation system of biological tissue and cell engineering. For such applications, we need to ascertain the presence of various fungi, bacilli, etc. on an object and approach any point of the object from any direction. To achieve the desired operation, we have developed a proto-type of a two-arm micromanipulator mounted on a rotary table around any given point on an object, allowing biological objects to be approached from any direction. The manipulation system is further comprised of a twin-arm manipulator mounted on a rotary table and a specimen stage. Each arm comes with three actuators superimposed one on the top of the other in order to move along the XYZ axial direction. The manipulator is driven by PZT actuators with magnifier elements and able to cover an envelop as wide as 200 μ m for each axis of X, Y and Z. The rotary table is supported by a pair of rollers set perpendicularly and driven by DC motor. The attitude of the roller pair is adjustable within three-degrees by the PZT actuators together with parallel plate magnifiers. In this paper, we investigate the need for a mechanism that permits controlled rotation around the principles of motion of our micromanipulation system, and the results of basic experiments with the system. [C2970]

"In situ infrared spectroscopic studies of molecular behavior in nanoelectronic devices"

An in situ Fourier-transform infrared (FTIR) spectroscopic technique has been developed to monitor molecular behavior in single-molecule thick nanoelectronic devices. This approach is applicable to a range of molecular-based devices and has the potential to provide researchers in the field with a tool to understand the molecular behavior that contributes to device performance. [C2971]

"Reconstitution of energy converting proteins in biocompatible materials"

As technology approaches a new era of device miniaturization, a compact and more efficient power source to drive these devices are in demand. It is worth exploring the potential of nanometer-scale hybrid organic/inorganic devices as an alternative to conventional power sources that have obvious limitations in size miniaturization. Some proteins in nature have played critical roles of energy conversion and transduction in biological systems over millions of years. There have been attempts to utilize energy converting proteins in laboratories in vivo. Although most in vivo experiments provide the most accurate recreation of the natural environments for membrane bound proteins, these conditions carry discrepancies from uncontrollable biological reactions. It is necessary to produce a more convenient experimental environment in which protein structure and function are maintained in vitro. We are engineering a biocompatible membrane embedded with energy converting proteins: bacteriorhodopsin (BR) and cytochrome oxidase (COX). Light absorption initiates transfer of protons by BR from one side of the artificial membrane to the other, creating an electro-chemical gradient that turn drives COX backwards. Reversed COX mechanism generates intermediates from O₂ to H₂O along with electrons. These electrons are attracted to a metal electrode that serves as current reservoir. The system converts optical energy to electrical energy, eventually allocating the derived energy to an external source. [C2972]

"Novel electrostatic discharge protection design for nanoelectronics in nanoscale CMOS"

technology"

A novel electrostatic discharge (ESD) protection concept by using the already-on device is proposed to effectively protect CMOS integrated circuits (IC) in nanoscale CMOS processes against ESD stress. Such an already-on NMOS device is designed to have a threshold voltage of 0 V, or even negative. When the IC is under the ESD zapping conditions, such already-on NMOS in CMOS IC are initially standing in the turn-on state and ready to discharge ESD current during any ESD zapping. So, such already-on NMOS has the fastest turn-on speed and the lowest trigger-on voltage to effectively protect the internal circuits with a much thinner gate oxide (15 E) in future sub-100 nm CMOS technology. To keep such already-on devices off when the IC is under normal circuit operating condition, an on-chip negative voltage generator realized by the diodes and capacitors is used to bias the gates of such already-on devices. The proposed already-on device and the on-chip negative voltage generator are fully process-compatible to the general sub-100 nm CMOS processes.

[C2973]

"Simulation study of hydrogen storage in two kinds of Y-junction carbon nanotubes"

The physisorption and chemisorption of hydrogen on two types of Y-junction carbon nanotubes (Y-(6,6) and Y(10,0)) have been studied using molecular dynamics (MD) simulations and semiempirical (AM1) method. The MD simulations study show that H₂ molecule can penetrate into the open ends of the branches and stay inside even at room temperature, which is confirmed by the study of potential energies for different pathways with AM1 method. Furthermore, the potential energy variation of H₂ penetrating into the open end along the axis of one branch arm is quite similar to that of H₂ in straight carbon nanotubes. The study of chemisorption of hydrogen atoms on Y (6,6) indicates that the carbon atoms in the heptagons are more active to bind hydrogen atoms. It has been also found that the neighboring carbon atoms of Y (6,6) prefer to bind two hydrogen atoms. [C2974]

"Computational study of the non-equilibrium flow of gases through carbon nanotubes"

Ultrafiltration membranes made of carbon nanotubes are expected to allow gases to selectively pass through them. This selectivity can be predicted from atomistic simulations of the diffusion and adsorption of the gases into and within the nanotubes. The computational nanofluidics of oxygen is therefore been studied with classical molecular dynamics simulations. The interactions in the system are modeled by a short-range reactive empirical bond-order potential coupled to a long-range Lennard-Jones potential. The transport of oxygen molecules for long time periods is characterized by an initial non-equilibrium state followed by an equilibrium state. The non-equilibrium state is characterized by diffusive motion of gas molecules from one end of the nanotube into the vacuum or low-pressure region at the other end of the nanotube, and lasts until the gases are evenly distributed inside the tube. During the non-equilibrium state, the molecules do not exit the nanotube, but rather move back and forth from one end to the other. It is found that this behavior, the time for the level-off, or attainment of equilibrium, and the molecular motions at the openings of the nanotubes are affected by the density (or pressure) of oxygen molecules both inside and outside of the nanotubes. In contrast, at the equilibrium state, for every molecule that enters the nanotube, one molecule exits at the other end. [C2975]

"High-fidelity modeling, heterogeneous simulation and optimization of synchronous nanomachines and motion nanodevices"

Rotational and translational nanomachines, controlled by nanoscale integrated circuits (nanolCs), can be widely used as actuators and sensors. The implications of nanotechnology to motion nanodevices have received meticulous consideration as technologies to fabricate these nanomachines have becoming developed. In particular, organic and inorganic micromachines (fabricated using CMOS and micromachining technologies), that serve as nanomachine prototypes and prove-of-concept paradigm, have been tested and characterized. In this paper we address and solve a spectrum of problems in synthesis, analysis, modeling and control of nanoscale permanent-magnet synchronous machines. All nanomachines and motion nanodevices must be synthesized before attempts to design and optimize them because basic physical features, nanomachine topologies, energy conversion, operating principles and other issues significantly contribute to sequential tasks in analysis, control, optimization and design. This is of particular significance for electromagnetic motion nanodevices including permanent-magnet synchronous nanomachines. This paper illustrates that depending upon the distinct analysis methods, different results are obtained. The fundamental, applied, and experimental results reported illustrate the validity and effectiveness of the results. [C2976]

"SET/CMOS universal literal gate-based analog-to-digital converter"

In this paper, we propose an analog-to-digital converter (ADC) using a hybrid single-electron-transistor/complementary metal-oxide-semiconductor (SET/CMOS) universal literal gate based on the Coulomb oscillation phenomenon of a SET. The SET/CMOS universal literal gate consists of the SET/resistor inverter and

the CMOS inverter, whose input is connected to the output of SET/resistor inverter. Because the CMOS inverter has the high input impedance and the low output impedance, the proposed circuit makes it possible to overcome the disadvantage of the high output impedance of a SET/resistor inverter by connecting its output to any input of CMOS circuit. The circuit has shown high immunity on temperature and can eliminate the background charge effect as applied to ADC. Using SPICE macromodel of SET at 30 K, we demonstrated the performance of a 4-bit ADC, composed of SET/CMOS universal literal gate and capacitive divider. These results can be simply extended to multi-bit ADC. [C2977]

"Nano- and microoptoelectromechanical systems and nanoscale active optics"

Significant progress has been made in nano- and microoptoelectromechanical systems (NOEMS and MOEMS) in last years. However, formidable challenges remain and novel design concepts are sought. The technologies has been developed to fabricate MOEMS that integrate nanostructures and nanodevices including mirrors, lenses, magnets, antennas, actuators, etc. We study MOEMS that integrate vertical cavity surface emitting laser (VCSEL), active optoelectromagnetic-active nanostructures (Bragg cells and optoelectromagnetic lenses), radiating energy nanodevices (antennas) and controlling/processing nanoscale integrated circuits (nanolCs). Ideally, this MOEMS should be designed and fabricated utilizing the Microsystem-on-Chip paradigm. This paper focuses on the fundamental problems in synthesis, system-level integration, high-fidelity modeling, heterogeneous simulation, data-intensive analysis and optimization. The results reported significantly contribute to newly emerging microoptosystems that can be used in wireless communication, laser scanners, optical interconnects, etc. [C2978]

"Coordination in pervasive computing environments"

Computer science and engineering nowadays appears to be challenged (and driven) by technological progress and quantitative growth. Among the technological progress challenges are advances in submicron and system-on-a-chip designs, communication technologies, micro-electro-mechanical systems, nano and materials sciences. The cast pervasion of global networks, the growing availability of wireless communication technologies for the wide, local and personal area, and the evolving ubiquitous use of mobile and embedded information and communication technologies are indicators for accelerated quantitative growth. We perceive a shift from the "one person with one computer" paradigm, which is based on explicit human machine interaction, towards a ubiquitous and pervasive computing paradigm, in which implicit interaction and cooperation is the primary mode of computer supported activity. This, however, poses serious challenges to the conceptual architectures of computing, and related engineering disciplines in computer science. [C2979]

"Ferromagnetism in Mn- and Co-implanted ZnO nanorods"

ZnO nanorods with typical lengths and diameters of 2 μm and 15-30 nm, respectively, were grown on Ag-coated Si substrate by catalyst-driven Molecular Beam Epitaxy and subsequently implanted with Mn+or Co+ions of dose ranging from $1\text{-}5 \times 10^{16} \text{cm}^{-2}$. The samples were then annealed at 700°C for 5 minutes. The structural properties were unaffected, but they exhibited ferromagnetism that persisted up to temperatures of 225-300 K. Coersive fields were ≤ 100 Oe even at 10 K. The results are similar to those obtained for implantation of Mn+and Co+ions in bulk, single-crystal ZnO, indicating the promise of nanorods for nanoscale spintronics. [C2980]

"Quantum electrical characteristics of nanocapacitors"

Current integrated circuit miniaturization will soon require device sizes at atomic scale. Recent work has proposed many Coulomb blockade, and tunneling devices as active devices. However, among passive components, capacitors are extremely critical circuit elements in all electronic circuits with wide range applications. In this work, we present the operational criteria that will govern the feasibility of nanocapacitors for future nanoelectronic circuits. [C2981]

"Growth of GaN nanowires on Si substrate using Ni catalyst in vertical chemical vapor deposition reactor"

GaN nanowires were successfully grown on Ni-coated Si substrate by direct reaction of gallium with ammonia gas in a home-made vertical tubular chemical vapor deposition reactor. The growth of GaN nanowires was uniformly observed across the Si substrate surface, but the density and average diameter of the nanowires varied along the position of the substrate surface. At the position of 5 cm above Ga source surface, the growth of GaN crystal grains was observed with few nanowires. The length of the nanowires reaches several micrometers. The clear lattice fringes in HRTEM image revealed the growth of good quality hexagonal single-crystal GaN nanowires. Photoluminescence of the GaN nanowires showed a strong band edge emission at the energy position of 3.4 eV with negligible deep level yellow emission. Field emission characteristics of the GaN

nanowires showed that the turn-on field of GaN nanowires was $7.4 \text{ V}/\mu\text{m}$ with a field enhancing factor β of 555. The catalytic growth mechanism of the GaN nanowires was discussed on the basis of experimental results in this work. [C2982]

"Anomalous growth of carbon-coated nickel silicide nanowires"

Carbon-coated nanowires were prepared on Ni catalyst loaded Si(100) wafer in an RF-CVD reactor. The nanowires grow straight with a length of more than $10 \mu\text{m}$. The average diameter of the nanowires ranged in 20-40 nm. HRTEM, EDX, Raman, and XRD measurements demonstrated the nanowires were 30-40 nm diameter SiNi nanowires coated with a 1.5-1.7 nm carbon layer. The turn-on field of the C-coated NiSi nanowires was estimated to be 3.6 eV and a field-enhancing factor β of 1500. The catalytic growth mechanism of the SiNi nanowires was discussed on the basis of experimental results in this work. [C2983]

"A new design technique of hybrid SET/CMOS static memory cells"

The single electron transistor (SET)/CMOS-based static memory cell is proposed. The negative differential conductance (NDC) characteristics of SET block help to realize very compact circuits for implementing the static memory cell, compared with the memory cells in conventional technologies. The proposed memory cell consists of one MOSFET and two back-to-back connected SET blocks having the NDC. The peak-to-valley current ratio of the SET block is above 5 with $\text{CG}=5.4\text{CT}$ ($\text{CT}=0.1\text{aF}$) at $T=77\text{K}$. A read and write operation of the proposed memory cell was validated with SET/CMOS hybrid simulation at $T=77\text{K}$. Even though the fabrication process which integrate MOSFET devices and SET block with NDC is not available, these results suggest that the proposed SET/CMOS static memory cell is suitable for a high density memory system with the low power consumption. [C2984]

"Ultra-small physical random number generators based on Si nanodevices for security systems and comparison to other large physical random number generators"

We propose a new application of silicon (Si) nanodevices for mobile communication security systems, one of the most important elements of information technology (IT). We introduce Si nanodevices having nanoscaled electron channels and electron traps that can generate high-quality random numbers for cryptographic security. This is an example of the fruitful fusion of nanotechnology (NT) and IT. [C2985]

"A nanochannel fabrication technique using chemical-mechanical polishing (CMP) and thermal oxidation"

We have developed a new nanochannel fabrication technique using chemical-mechanical polishing (CMP) and thermal oxidation. With this technique, it is possible to control the width, length, and depth of the nanochannels without the need for nanolithography. The use of sacrificial SiO_2 layers allows the fabrication of centimeter-long nanochannels. In addition, the fabrication process is CMOS compatible. We have successfully fabricated an array of extremely long and narrow nanochannels (i.e. 10 mm long, 25 nm wide and 100 nm deep) with smooth inner surfaces. [C2986]

"Custom fabrication of freestanding and suspended three-dimensional polymer structures"

An atomic force microscope (AFM) is used as a micromanipulator to fabricate freestanding micron diameter wires and bridges in a matter of minutes by pulling polymer materials into fibers. The fabrication procedure appears to have significant application in easier and more rapid prototyping of micro-, nano- and MEMS devices. While fiber pulling technology has advanced to high degrees of perfection, our process represents the first time that a nano-positioning tool has been used to fabricate three-dimensional microstructures with a degree of flexibility and simplicity far exceeding traditional MEMS and microfabrication processing methods. Preliminary efforts at demonstrating the use of the fibers in device fabrication and applications are also presented. [C2987]

"A novel application of resonant tunneling devices in high performance digital circuits"

Resonant tunneling devices have been used in various digital circuit applications to improve packing density, circuit speed, as well as power consumption. In this paper, we describe a new class of applications of using those quantum tunneling devices in digital circuit design. More specifically, we have developed a strategy to use RTDs in conjunction with CMOS logic circuits that leads to new circuits that have elevated noise immunity. The proposed method utilizes RTD's negative differential resistance property and the fact that they have very high speed index. We have shown through simulation that the proposed circuits have increased noise immunity yet they retain all the advantages of CMOS dynamic circuits. The benefit of the proposed circuits is still evident using currently available silicon-based RTD's with a relatively small peak-to-valley current ratio. [C2988]

"GP based transistor sizing for optimal design of nanoscale CMOS inverter"

This paper proposes a simple method to formulate the transistor sizing problem as a geometric program (GP) by using a modified I-V model which performs well up to 10 nm. The geometric program model for dynamic power delay product (PDP) expression has been formulated by using the modified I-V model for nanoscale CMOS inverter. The model has been solved efficiently, which generates a number of important practical consequences. This method computes the absolute limit of performance for given input frequency and load capacitance of a transistor and technology parameters. The accuracy of performance prediction in the transistor-sizing (through geometric programming) problem is verified due to its closeness to SPICE simulation (250 nm) results. Further the approach has been extended to predict the transistor sizing for nanoscale (up to 50 nm) CMOS inverter and the simulation results of the proposed model are compared with the Berkeley Predictive Technology Model (BPTM) to establish the usefulness of the approach. [C2989]

"Examination and improvement of reading disturb characteristics of a surrounded gate STTM memory cell"

This paper introduces a novel surrounded gate STTM cell technology to improve retention and read disturb characteristics. In the memory cells previously reported, the device structures limits the CMOS-compatible memory integration and the operation voltage scaling of the memory cells. The proposed cell architecture overcomes this problem and also improves the read disturb characteristics. The proposed memory cell was fabricated using the 0.18 μm design rule based on the low power SRAM process technology. This paper demonstrate an the device characteristics of the proposed memory cell and the improvement of tin a read disturb characteristics. [C2990]

"Transistor with electrically induced quantum wire channel"

Quantum wire was electrically realized using conventional Si process technology. Channel lateral junction and gate bias induced surface band bending resulted in potential well. MOSFET with hole channel of this wire-like potential exhibited conductance oscillation, which was explained by subbands formation in the twin well at the lateral junction. Potential confinement in two dimensions also caused high photo-sensitivity in this device. [C2991]

"Subwavelength nanolithography using surface plasmons"

We have investigated the novel plasmonic nanolithography by exposing a photoresist layer through a plasmonic mask, which is an opaque metal film with subwavelength hole arrays in it. The hole arrays of various diameters are fabricated by using focused ion beam (FIB). Through the lithography, the hole array patterns are transferred to negative photoresists. As a result, high contrast dot arrays with the smallest diameter of 120 nm, equivalent to $\lambda/3$, are observed by atomic force microscope (AFM). [C2992]

"A robust design for fully-silicided electrostatic discharge protection devices in sub-100 nm CMOS circuit era"

In this paper we present a novel experimental methodology in studying a robust fully-silicided ESD protection device. The results demonstrate that the proposed floating body design is amenable to implement in sub-100 nm CMOS circuit. The design exhibits an excellent efficiency on both protection and chip area. This original technique is attractive to advanced CMOS circuit design; in particular for the consideration of ultra-thin gate-oxide reliability. [C2993]

"Neural network synapse device using single-electron tunnel junctions"

We propose a novel single-electron synapse device using parallel-coupled ultra-small tunnel junction arrays. The switching function and the ohmic characteristic of the coupled arrays are exploited and their robustness to the background-charge fluctuation effect is examined. Based on the synaptic function of the coupled arrays, we propose two types of the Hopfield neural networks which can operate with minimal errors: one directly corresponds to a CMOS neural network architecture and operates with binary-weight, analog-signal. The other one is an ordinary Hopfield network having binary-signal, analog-weight. [C2994]

"Single-electron transistor using self-aligned sidewall spacer gates on silicon-on-insulator nanowire"

A dual-gate-controlled single-electron transistor was fabricated by using self-aligned polysilicon sidewall spacer

gates on a silicon-on-insulator nanowire. The quantum dot formed by the electric field effect of the dual-gate structure was miniaturized to smaller than the state-of-the-art feature size, through a combination of electron beam lithography, oxidation and polysilicon sidewall spacer gate formation processes. The device shows typical MOSFET I-V characteristics at room temperature. However, the Coulomb gap and Coulomb oscillations are clearly observed at 4 K. [C2995]

"Nanoscale polymer field-effect transistors"

Regioregular poly thiophene has been successfully used in large-area FET'S on account of its excellent self-assembly properties. We describe the characteristics of regioregular polythiophene FET's with various geometry configurations and channel lengths down to 4 nm. The effects of shrinking channel length were investigated for 100 nm 40 nm channel length FET's with source and drain patterned by a special design of large W/L ratio. Nanometer scale gaps down to 4 nm were formed by electrostatic trapping followed by electro migration processes. The impact of gap geometry was discussed. To suppress the spreading current effects, we employed a pair of guarding electrodes near the two sides of the channel which were kept at the same potential as the drain. The true responses of these nanometer scale FET's exhibit pronounced short-channel effects due to the thick gate insulator used (100 nm) relative to the channel lengths. Our home-developed numerical model simulated the behavior of a 5 nm channel FET and reasonable agreement with the experimental data was obtained. [C2996]

"Silver-tetracyanoquinodimethane (Ag-TCNQ) nanostructures and nanodevice"

Ag-TCNQ nanostructures are synthesized by using both solution reaction in acetonitrile and a novel vacuum vapor reaction method. Experiments show the latter synthesis method can produce Ag-TCNQ nanowires with high quality. They have diameters around 100 nm and lengths around 5 μm . These nanowires could be potential building blocks for nanoscale electronics. Nanodevices based on these nanowires are fabricated using electron beam lithography technique. Electrical properties are characterized and I-V hysteresis is observed reproducibly, which shows memory effect with electrical switching of four orders on-off ratio. Ag-TCNQ nanowires' electrical properties make them promising candidates for future applications as ultra-high density information storage media. [C2997]

"Quantum mechanical modeling of advanced sub-10 nm MOSFETs"

We have carried out numerical modeling of sub-10 nm double-gate Si MOSFETs with ultra-thin, intrinsic channel connecting n+-doped source and drain, using the self-consistent solution of the Schrodinger and Poisson equations. Two simple models of transistors with raised electrodes and with thin source and drain extensions are compared. Results show that devices of both types can be scaled to at least 5 nm gate length. However, already below 10 nm the exponentially growing sensitivity of transistor parameters (in particular, the gate voltage threshold) to very small variations of device size may become a major challenge for the Moore's law extension beyond this frontier. [C2998]

"New optimal design strategies and analysis of ultra-low leakage circuits for nano-scale SOI technology"

This paper proposes new SOI circuit strategies for simultaneous reduction of standby gate and sub-threshold leakages. Various enhanced MTCMOS design alternatives are analyzed. A new method for assigning the VTH and sizes of header and footer transistors is proposed, and stacking of headers/footers is analyzed. The optimum stacking height and tapering/sizing ratio under various design constraints are determined. Our strategies reduce MTCMOS standby leakage further by as much as 20% and reduce virtual supply noise by 15%. [C2999]

"Detailed heat generation simulations via the Monte Carlo method"

As current device technologies advance into the sub-continuum regime, they operate at length scales on the order of the electron and phonon mean free path. The ballistic conditions lead to strong non-equilibrium at nanometer length scales. The electron-phonon interaction is not energetically or spatially uniform and the generated phonons have widely varying contributions to heat transport. This work examines the microscopic details of Joule heating in bulk silicon with Monte Carlo simulations including acoustic and optical phonon dispersion. The approach provides an engineering tool for electro-thermal analysis of future nano-devices. [C3000]

"Quantum cellular nonlinear networks using Josephson circuits"

Quantum cellular nonlinear networks (CNNs) using superconducting circuits of Josephson junctions are proposed

as an implementation of a massively parallel computing architecture. The quantum CNN architecture presents a novel computing paradigm, other than quantum computing and classical computing based on binary logic, for the use of Josephson circuits. Some issues in actual implementation are tentatively discussed. [C3001]

"Toward development of nano-materials composed of artificial proteins and nano-carbons"

Fusion materials composed of proteins and nanostructured carbons have a significant potential in various fields including pharmaceuticals, semiconductor technology and material engineering. For example, the internal space of single-wall carbon nanohorns (SWNHs) can be used as a new tool for a drug delivery system (DDS) or a noninvasive imaging system in which proteins would endow biocompatibility and organ specificities to the nanostructured carbons. To translate these potential capacities of the SWNHs into practical applications in the medical area, it is necessary to create artificial proteins that specifically bind to SWNHs and carry the desired biological function(s). In this presentation, we will describe our efforts to develop protein and nano-carbon hybrid materials using our newly established MolCraft methodology. With MolCraft, a single microgene is first designed so that a number of functional motifs would be coded by different coding frames, and then the designer microgene is polymerized in a head-to-tail manner to create repetitious artificial genes. The resultant microgene polymers produce proteins that are combinatorial polymers of embedded functional motifs, among which functional clones are selected. As the first step in the construction of fusion materials composed of protein and SWNHs, we have selected peptide motif, from peptide-display phage libraries that specifically recognize SWNHs. By embedding the determined motif into a microgene, several artificial proteins have been created by MolCraft. [C3002]

"Memory arrays based on molecular RTD devices"

Recently, molecular devices have been fabricated which exhibit I-V characteristics similar to those of solid-state resonant tunneling diodes (RTDs), including negative differential resistance (NDR). These molecular devices very well could overcome many of the limitations of their solid-state counterparts while also offering promise for the future of VLSI technology. In this paper we examine the operation of an RTD based circuit, often called a Goto pair, which can be used to latch digital data. We focus on a first-in first-out (FIFO) memory architecture where no devices are required to select individual bits in the memory array and only the molecular devices and their interconnect are required for the memory core. Some design considerations and methodologies are also described along with two methods for implementing control logic for the FIFO. Although a long term goal would be to use nanoelectronic components, we describe here how CMOS can be used for control logic as part of a CMOS/Nano co-design methodology. [C3003]

"ANTS for Human Exploration and Development of Space"

The proposed Autonomous Nano-technology Swarm (ANTS) is an enabling architecture for human/robotic mission envisaged by NASA's mission for the Human Exploration and Development of Space (HEDS). ANTS design principles draw on successes observed in the realm of social insect colonies, which include task specialization and sociality. ANTS spacecraft act as independent, autonomous agents for specific functions, while cooperating to achieve mission goals. For example, the Prospecting ANTS Mission (PAM) is a long-term mission concept for the 2020-2025 time frame involving individual spacecraft agents that are optimized for specific asteroid prospecting functions. The objective of PAM is to characterize at least one thousand asteroids during each year of operations in the main belt. To achieve this objective, PAM spacecraft, individually and as a group, must achieve a high level of autonomy. This high degree of autonomy opens the possibility of a new kind of interaction between humans and these spacecraft, where human explorers and developers could interact with ANTS enabled resources by communicating high-level goals and data products. Thus ANTS enables new kinds of missions in which human and robotic agents work together to achieve mission goals. In this paper we review and discuss the ANTS architecture in the context of the HEDS mission. [C3004]

"Noise considerations and detailed comparison of low standby gate/sub-threshold leakage digital circuits in nano-scale SOI technology"

In this paper, we present a comparison of 4 low leakage techniques from noise considerations, and discusses their suitability for currently used PD-SOI and future FD-SOI devices. [C3005]

"Micro-powder blasting using nano-particles dispersed polymer mask"

A new microfabrication technique to realize rapid prototyping of a glass was proposed. This technique consists of laser patterning of Au nano-particles dispersed polymer and micro-powder blasting. The patterned polymer was utilized as a mask material for the subsequent mechanical removal of the glass by the micro-powder blasting. Five different polymers were tested for the matrix material. Using a line and hole mask pattern, the fabricated

channels in the glass with maximum aspect ratio of 2.1 was realized and the prototype chip was produced. From this result, the validity of the micro-powder blasting using Au nano-particle dispersed polymer mask was confirmed. Moreover, we proposed the micro-powder blasting technique with elevated polymer mask temperature. Utilizing this method, improvement of the polymer mask erosion resistance was achieved. [C3006]

"SOI nano-technology for high-performance system on-chip applications"

This paper presents the potential of the SOI technology in the nanometer regime for high-performance applications integrating the RF transceiver with the microprocessor and its embedded DRAM. Owing to its low-parasitic and high-Q passives integrated in a standard micro-processor technology, SOI CMOS can expand CMOS technology into the millimeter-wave frequency. Several examples of CML, VCO and amplifier circuits are provided. [C3007]

"New trends in low power SoC design technologies"

Summary form only given. The growing complexity of system-on-chip (SoC) continues to advance the concept of low power devices/circuits/architectures/algorithms co-design. This requires the close interaction among various disciplines to be involved in the development of low power high performance computer, communication and consumer SoC applications. The design of low power wireless mobile SoC products now must equally concern itself with digital and analog mixed-signal devices and circuits, interconnection wires and nano-scale CMOS technology. The reduction of the power consumption in low voltage circuits is necessary to reduce the leakage power in both the active and standby modes of operation. The reduction in leakage current in design has to be achieved using circuit-level and physical-layout techniques. This tutorial paper first considers major circuit techniques and then considers physical-layout techniques for leakage control and reduction. This paper also considers voltage island techniques, concurrent mixed-signal semi-custom design methodology, dual-supply techniques for regular logic fabric VPGA and cache memory, system-level power management, and silicon-implementation platform design. [C3008]

"Motion sensing for robot hands using MIDS"

A novel computer input system-the Micro Input Devices System (MIDS)-is under development by merging MEMS sensors and existing wireless technologies. This system could potentially replace the functions of the mouse, pen, and keyboard as input devices to the computer. The system could also be used as a general wireless 3D motion sensing device. In this paper, we will present our work on using MIDS for motion sensing application of robot hands. MIDS is used to evaluate the performance of PD adaptive control and Impedance control schemes in manipulating a five-fingered robot hand and in manipulating this hand to grasp a ball. Experimental results indicate that MIDS is capable of obtaining real-time 3D acceleration/vibration data wirelessly for the robotic hand, hence eliminating the need to perform the time-consuming integration of the position sensor data to obtain acceleration. Moreover, our initial results also indicate that further exploration of this technology could eventually produce a new control-input device for robotic grasping manipulators. These results are presented in this paper. [C3009]

"Protein-based self-assembly bridging system with cassette tags"

The affinity of gold particles to thiolated DNA strands with complementary sequences has been utilized extensively for self-assembly systems in the scale ranging from micrometers to nanometers. This paper represents a new approach based on the method of protein-based self-assembly system using the property which has been employed in protein purifications for years that Ni-NTA (nickel-nitrilotriacetic acid) resin shows remarkable selectivity to proteins containing an affinity tag of amino acid residues cassette composed of six consecutive histidine residues, i.e., 6xHis tag. The designs and utilities of protein-based self-assembly system can be carried out with: (1) antibody/antigen-based self-assembly, (2) receptor/ligand-based self-assembly, (3) oligopeptide/oligopeptide-based self-assembly, and (4) DNA/DNA-binding protein-based self-assembly, etc. The modification of proteins with 6xHis tags, for being immobilized on the Ni-NTA pre-coated inorganic materials, can be prepared using commercialized protein expression systems or developed peptide synthetic techniques. The modified proteins would be linked onto the treated particles dictated by the affinity between Ni-NTA and 6xHis moiety. Then, mixing the two different proteins linked particles would cause the self-assembly between two particles via the interactions of utilized protein-based self-assembly systems. In addition to the demonstrated model using the affinity of 6xHis tags to chelated nickel ions proposed in this study, protein with exposed imidazole rings of histidines also have affinity for certain transition metal ions, such as Mn^{2+} , Fe^{3+} , Co^{2+} , Cu^{2+} , and Zn^{2+} , etc., for linking up the proteins or oligopeptides to inorganic materials. Due to the development of genetic engineering and solid phase peptide synthesis technologies, the ease of producing recombinant proteins or synthetic oligopeptides makes the choice of protein-based self-assembly materials more versatile and

convenient than its counterparts. The protein-based self-assembly systems with cassette tags can be options in addition to the well known DNA-based self-assembly method, i.e., the affinity of gold particles to thiolated DNA strands with complementary sequences, thus broaden up the scope for "bottom-up- " fabrication approaches in nanotechnology. [C3010]

"Three dimensional polymer MEMS with functionalized carbon nanotubes and modified organic electronics"

Polymer based MEMS is rapidly gaining momentum due to their potential for conformability and other special characteristics not available with silicon microsystems. The polymer based nano- and micro-devices are flexible, chemically and biologically compatible, available in many varieties, and can be fabricated in truly 3-D shapes. The conceived devices thus are cheap and disposable. However, in order to conceive fully functional microsystems, necessary electronics have to be integrated. A modified organic thin film TFT is used for such integration. Although the existing technology of organic TFTs can not rival the well-established silicon semiconductor technology, especially in terms of speed, they are still useful in displays, disposable devices, and sensors. Although organic TFT and polymeric MEMS have several common features that make them compatible with each other, to the best of our knowledge, no serious attempt has been made thus far for combining these technologies. This paper is aimed at bridging this gap. Examples of potential microsensors and systems, such as accelerometers and gyroscopes derived from polymer with functionalised carbon nanotubes are presented. A sensor-in-shoe demonstration will be performed at the Conference. Many issues and challenges in the design and development of polymer-based sensors with organic electronics are also addressed. [C3011]

"Carbon nanotube devices for future nanoelectronics"

We examine key features of the electrical performance of carbon nanotube field-effect transistors and consider their viability as potential building blocks of a future nanoelectronics technology. [C3012]

"Multi-scale analysis and design of nano imprint process"

Nanometer-sized structures are being applied to many fields including micro/nano electronics, optoelectronics, quantum computing, biosensors, etc. Nano imprint technology is one of the most promising methods for manufacturing the nanometer-sized structures. The crucial element for the nano imprint technology is the nano-resolution printing technique using polymeric stamps. In this study, a multi-scale analysis scheme for simulating the nano imprint process is proposed and some useful results are presented. Using the slip-link model, the dependency of viscoelasticity on molecular weight of polymer stamp is predicted. Deformation behaviors of polymeric stamps are analyzed by finite element method based upon the predicted viscoelastic properties. The obtained results can be used to design the nano imprint process. [C3013]

"Artificial atoms and molecules for spintronic applications"

Single spin manipulation in single and double quantum dots provides the necessary ingredients for a plausible scenario toward the realization of a scalable quantum computer with GaAs semiconductor technology. [C3014]

"Coherence and dephasing in self-assembled quantum dots"

We measured dephasing times in InGaAlAs self-assembled quantum dots at low temperature using degenerate four-wave mixing. At 0 K, the coherence time of the quantum dots is lifetime limited, whereas at finite temperatures pure dephasing by exciton-phonon interactions governs the quantum dot coherence. The inferred homogeneous line widths are significantly smaller than the line widths usually observed in the photoluminescence from single quantum dots indicating an additional inhomogeneous broadening mechanism in the latter. [C3015]

"New ultra-precise semiconductor and metal nanostructures: tubes, shells and their ordered arrays"

The brief overview focuses on the fabrication methods and properties of new ultra-precise nanotubes, nanoshells formed from single-crystal Al_{0.5}B_{0.5} and Si/GeSi strained heterofilms. Results on the formation of periodic structures, open and closed nanoshells of various shapes with the minimum radius of curvature of 1 nm are described. Properties of tubes containing electron gas and of ordered arrays of quantum dots are discussed. The fabricated nanoshells offer much promise as building blocks for nanoelectronic and nanomechanical devices, their fabrication technology being quite compatible with the integrated-circuit technology. [C3016]

"Temperature dependence of nanopatterning of inhomogeneously strained surfaces"

The temperature and deposition rate dependence of nanopattern formation on inhomogeneously strained surfaces is investigated by means of kinetic Monte Carlo simulations. This study proposes that technologically achievable strain fields (that often are less than 1%) can be used to produce high-quality nanopatterns. We predict that ordered nanopatterns can be achieved even for small surface strain-field modulations if the temperature and deposition rate are large enough. To observe this effect, the mean adatom surface diffusion length has to be more or less equal to the period of the strain field. On the other hand, for larger strain-field modulations good nanopatterning can be achieved for a wide range of growth rates, especially at low temperatures. [C3017]

"A coupled circuit and device simulator for design of RF MEMS VCOs"

A new coupled circuit and electrostatic/mechanical simulator is presented for the design of RF MEMS VCOs. The numerical solution of device level equations is used to accurately compute the capacitance of the MEMS capacitor. This coupled with a circuit simulator facilitates the simulation of circuits incorporating MEMS capacitors. Simulations of a 2.4 GHz VCO implemented in a UP 0.5 μm CMOS technology show good agreement with experimentally observed behavior. [C3018]

"Neuromorphic CMOL circuits"

This is a brief review of the recent work on the development of neuromorphic architectures for future hybrid CMOS/nanowire/MOLecular ("CMOL") circuits. Such circuits may provide the first chance for the implementation of advanced information processing systems with areal density of (beyond 10^{12} active functions per cm^2) comparable to that of the human cerebral cortex, while operating at much higher speed (up to 10^{20} operations per second per cm^2), at acceptable power consumption. Our group has suggested a family of distributed crosspoint networks ("CrossNets") that are natural for implementation in CMOL technology, and has shown that such networks may be trained to perform at least the effective pattern recognition in the Hopfield mode. Work on CrossNet training to perform more complex tasks is under way. [C3019]

"Strategy and prototype tool for doing fault modeling in a nano-technology"

Quantum-dot cellular automata (QCA) has been proposed as a replacement for CMOS circuits. The major difference between QCA and CMOS is that electronic charge, not current, is the information carrier. A complete set of logic gates has been created and some have been experimentally tested with metal-dots acting as quantum dots. Molecular implementations are currently being examined. This work examines the possible defects that may occur in the fabrication of both types of QCA systems. Fault models for these defects are developed, and a prototype tool with a strategy for fault modeling is outlined. [C3020]

"Fabrication and photoluminescent properties of ZnO/ZnMgO quantum structure nanorods"

We report the epitaxial growth of ZnO/ZnMgO nanorod quantum structures and their structural and photoluminescent characteristics. The nanorod quantum structures grown using low pressure, metal-organic vapor phase epitaxy (MOVPE), exhibit uniform width and length distributions. Typical diameters and lengths of nanorods were in the range of 20-70 nm and 0.5-2 μm . During the nanorod growth, ZnO/ZnMgO superlattices with their periodic thicknesses of 46-145 Å were fabricated by depositing ZnO and ZnMgO layers alternatively. Furthermore, quantum confinement of carriers in the superlattice nanorods was observed using photoluminescence (PL) spectroscopy. [C3021]

"New design for magnetic storage elements of micro power supplies"

In the fast growth context of micro-electromechanical systems (MEMS) applications, an important improvement of power supplies "power-to-weight" ratio can be obtained through the integration of magnetic storage elements with their associated electronic environment. These components are usually used to transfer and store high energy densities with high magnetic flux. But up until now, integrated devices with these inductive elements were mainly limited by low inductance and current values. To make optimised new designs and achieve realisation of such inductive elements, we propose a new complete methodology, illustrated through a micro-machined square planar inductor. Indeed, after defining specifications (power, inductance value, frequency, geometrical dimensions), a mathematical method is used to define a first geometrical parameters set. To achieve it, several simulations are conducted with CAD tools dedicated to MEMS technology. Our method is based on a new specific last nano-imprint technology we have developed in our laboratory and adapted, in parallel, to our application [C3022]

"MEMS and NEMS technologies for wireless communications"

This paper presents a new family of components based on the MEMS and NEMS (nano-electromechanical system) concepts. They show very attractive properties for future wireless communications systems. The design of such components involves both electromagnetic simulations and mechanical and thermal modelling in order to get an accurate description of their electrical behavior. [C3023]

"Use of dispersant in high K polymer-ceramic nano-composite to improve manufacturability and performance of integral capacitors"

Integral or embedded capacitor technology could increase packaging density, improve electrical performance and reduce assembly cost compared with traditional discrete capacitor technology. Developing a successful dielectric material that satisfies electrical, reliability and processing requirements is one of the major challenges for incorporating capacitors into the large-area substrates. Polymer-ceramic nano-composites have been of great interest as the high dielectric constant (K) material because they combine the processability of polymers with the desired electrical properties of ceramics. Nevertheless, there are some technical barriers for the polymer-ceramic composites to be used in the organic substrates. Most significantly, for a very high dielectric constant of about 150 as reported so far by our group, a necessary rather high ceramic filler loading (85% by volume) gave problems in well dispersion of the ceramic fillers within the organic matrix, and there was almost no adhesion towards other layers in the printed circuit board structure. In order to develop polymer-ceramic nano-composites with a dielectric constant as high as possible together with compatibility toward manufacturing process of organic printed circuit boards, we have introduced dispersants into the formulations. Comprehensive formulation techniques have resulted in a much higher dielectric constant (e.g., typically over 65 at a ceramic loading of 40% by volume) as well as excellent adhesion performance. [C3024]

"On dynamic delay and repeater insertion"

In deep sub-micron technologies, as the wires are placed ever closer and signal rise and fall times go into the sub-nano second region, increased crosstalk has implications on the data throughput and on signal integrity. Depending on the data correlation on the coupled lines, the delay can either decrease or increase. Here we show that in uniform coupled lines, the response for several important switching configurations has a dominant pole characteristic. This allows easy prediction for the average, worst-case and best-case delay of buffered lines. We show that the repeater numbering and sizing can be optimised to deal with crosstalk under different constraints to best match the application. Area and power issues are considered and all equations are checked against a dynamic circuit simulator (SPECTRE). [C3025]

"High-speed and low-power cellular non-linear networks using single-electron tunneling technology"

We investigate the use of nanoelectronic structures in cellular non-linear networks (CNN) for potential applications in future high-density and low-power CMOS-nano device hybrid circuits. We first discuss simple CNN linear architectures using single-electron tunneling (SET) transistor summing-inverter circuits, which are capacitively coupled to the inputs and outputs of nearest neighbor cells. Monte Carlo simulation results are then used to show CNN-like behavior in realizing different functionality such as shadowing. The SET-CNN circuit was optimized to operate at 1 GHz, which is a desirable feature for high-speed image processing applications. Finally, we estimate the power consumption of the SET-CNN and compare it to a state-of-the-art CMOS processor [C3026]

"Organic molecules and composites with applications in micro and nanoelectronic systems"

The present work is aimed at the review of the technical specifications and opportunities offered by several classes of organic molecules and nanocomposites in micro and nanoelectronics. The paper focuses on a few examples of prototypes and related technologies of interest in the field of organic electronics and molecular electronic devices, by setting up the main technology limitations and new fabrication techniques to achieve industrial nano-organics technologies aimed at mass production. [C3027]

"Proceedings IEEE Computer Society Annual Symposium on VLSI. New Paradigms for VLSI Systems Design. ISVLSI 2002"

The Symposium covers a range of topics: from VLSI circuits, systems, and design methods to system level design and system-on-chip issues, to bringing VLSI experience to new areas and technologies like nano- and molecular devices. Future design methodologies are also one of the key topics at the symposium, as well as new CAD tools to support them [C3028]

"Effects of post-decoupled-plasma-nitridation annealing of ultra-thin gate oxide"

First Page of the Article [C3029]

"Miniaturized 1 inch dual servo pick-up actuator"

In this paper a miniaturized 1 inch actuator is studied and designed for optical disk drive (ODD) systems. In particular, it is adapted in an NFR system (K.H. Kim et al, KSPE, vol. 18, no. 8, pp. 174-181, 2001) using a SIL (solid immersion lens) system. It is a dual servo actuator, which consists of a fine actuator and a coarse actuator. Its actuating force generation method uses a VCM (voice coil motor). The fine actuator is composed of 4-wire suspensions and a bobbin wrapped by coils. The coarse actuator has coils and a V-groove guide system. [C3030]

"Atomic layer deposition (ALD) technology for reliable RF MEMS"

A nano-layer inorganic coating technology has been developed to protect RF MEMS from electrical shorting as well as long-term reliability failures due to charging or moisture. The combination of alumina dielectric and zinc-oxide conducting layers can be constructed one atomic layer at a time. At 177°C, the released RF MEMS devices can be coated on a wafer or as a single device with conformal, inorganic coverage where the thickness and electrical conductivity can be controlled to meet desired values. With additional chemical treatment, the surface could be made hydrophobic to avoid moisture-induced stiction. The long-term reliability problem is the main barrier that impedes the growth of RF MEMS applications. This novel atomic layer deposition (ALD) technology can help in overcoming this limitation [C3031]

"Electrical and material stability of Orion™ CVD ultra low-k dielectric film for copper interconnection"

The electrical and material stability of a newly developed CVD ultra low-k dielectric material called Orion, is explored. It has a dielectric constant of less than 2.2 with excellent thermal stability up to 600°C. It shows very low leakage current of only 1 nA/cm² at 2.5 MV/cm. Although both Al and Cu ions can be driven into Orion easily, no metal ions are observed in the Orion with a TaN gate. The Orion material also shows very good adhesion with TaN and oxide hardmask. The current transport mechanism and electrical reliability were investigated. Although weak dielectric polarization occurs under bias-temperature stress, Orion is a very promising material for next generation Cu-interconnect technology. [C3032]

"Evaluation and analysis for mechanical strengths of low k dielectrics by a finite element method"

We evaluated elastic modulus of various porous and nonporous inorganic low-k films by means of a nano-indentation. The elastic modulus of various low-k films shows a linear dependence on the film density for porous and nonporous inorganic low-k materials, respectively. We have studied the effect of pore aggregation on the elastic modulus of thin films by the finite element method (FEM) using the 2-dimensional random pore generation model. The FEM results for the elastic modulus, which were calculated for the 2-dimensional random pore model, fit extremely well with the experimental data obtained by the nano-indentation method. [C3033]

"Processability and performance enhancement of high K polymer-ceramic nano-composites"

Integral or embedded capacitor technology could increase packaging density, improve electrical performance and reduce assembly cost compared with traditional discrete capacitor technology. Developing a successful dielectric material that satisfies electrical, reliability and processing requirements is one of the major challenges for incorporating capacitors into the large-area substrates. Polymer-ceramic nano-composites have been of great interest as the high dielectric constant (K) material because they combine the processability of polymers with the desired electrical properties of ceramics. Nevertheless, there are some technical barriers for the polymer-ceramic composites to be used in the organic substrates. Most significantly, for a very high dielectric constant of about 150 as reported so far by our group, a necessary rather high ceramic filler loading (85% by volume) gave problems in well dispersion of the ceramic fillers within the organic matrix, and there was almost no adhesion towards other layers in the printed circuit board structure. In order to develop polymer-ceramic nano-composites with a dielectric constant as high as possible together with compatibility toward manufacturing process of organic printed circuit boards, we have introduced dispersants into the formulations. Comprehensive formulation techniques have resulted in a much higher dielectric constant (e.g., typically over 65 at a ceramic loading of 40% by volume) as well as excellent adhesion performance [C3034]

"National Science Foundation research initiatives"

NSF has been pioneer of new research activity and education reforms. To keep the pace with technology, new development dealing with changes in engineering and industry has been a concern. For example, the problem facing the power industry transmission systems are solved by a range of advanced methods, in science and technology. They range from information technology, computational intelligence, nano-technology, complex network/transportation research, and sensor systems and educational outreach and curriculum reform to promote highly motivated workforce in support of NSF mission. In response to these needs, several initiatives and some promising ones, which are in the process are discussed in this presentation. [C3035]

"MFM study of magnetic bit patterns of different dimensions"

Summary form only given. The focused ion beam (FIB) technique was utilized to pattern the commercial post-sputtering longitudinal recording media into individual bits of different dimensions. A number of horizontal and vertical lines were milled to separate the bits. The MFM observation was employed to study the magnetic property of each bit and the interaction between "transitions" created by the discontinuity of magnetization at the edges of bits. The single domain structures were formed spontaneously as the bit dimension is reduced to 200 nm or less. We demonstrate the new interplay between the magnetostatic energy and exchange energy for patterned media bits. [C3036]

"Development of the large current cluster ion beam technology"

A cluster is an aggregate of a few to several thousands atoms. Because many atoms constituting a cluster ion bombard a local area, high-density energy deposition and multiple-collision processes are realized. Because of the interactions, cluster ion beam processes can produce unusual new surface modification effects, such as surface smoothing, high rate sputtering and very shallow implantation. High ion dose is needed to realize the nano-level smoothing and etching of hard materials. It is necessary to develop the technology of large current cluster ion beam for the purpose of increasing the productivity of processing using cluster ion beam. In order to achieve large current cluster ion beam, the cluster generation, ionization and ion transportation were studied. The efficient cluster generation was realized by increase of source gas pressure. The mass distributions of Ar cluster beams generated from a Laval nozzle were measured with a Time-of-Flight (TOF). The distributions prove that the neutral beams include clusters with the size up to 160000 atoms. The efficient ionization and extraction were realized by structural improvement of the ionizer. The ionization efficiency increases with the emission current. When the emission current is 100mA, the ionization efficiency reaches about 80 %. The structural improvements of ionizer suppressed the loss of ions by coulomb repulsion and realized the extraction of large current cluster ion beams. As a result, when the gas pressure was 15000 Torr and the electron emission current is 300 mA, the beam current reached 500 μ A. The cluster ion dose of more than 1.4×10^{16} ions/cm² is needed to realize the nano-level smoothing. With this beam current, 6 inches wafers can be treated for about 10 minutes. [C3037]

"Nano Crystal Memory Devices Characterization Using the Charge Pumping Technique"

{no data available} [C3038]

"LSI design in the 21st century: key changes in sub-1V giga-integration era"

Summary form only given. Conventional CMOS technology will face difficulties in the sub-0.1 μ m, sub-1 V region. Random-modulation CMOS, which assigns multiple threshold levels in the same block through the use of sophisticated CAD tools, will emerge as a key technology in this new regime. Beginning with this first step, the era of "complex CMOS", which requires complicated design elaborations and operating control, is predicted to begin. This key change will open up opportunities for new methodologies and CAD tools. Another major change in trend will be the shift in System-on-Chip design methodology from being processor-centric to either memory-centric or communication-centric, depending on the application. In the former case, nanostructured memory technology will be a key innovation, which requires completely new design expertise, including quantum physics. In the latter case, real IP reuse is the key, which will be enabled by a new specification language, such as the Object Wrapper language. Our efforts to standardize this new language and its design methodology are also introduced [C3039]

"Physical removal of nano-scale defects from surfaces"

As semiconductor device feature size shrinks to 100 nm and smaller, the removal of nano-scale defects presents a tremendous challenge to the industry. There is a need to understand the particle removal mechanisms and recognize their advantages and limitations. In this paper, a particle removal model is modified to be able to consider soft particle deformation. The effect of decreasing particle size down to the nano-scale and its effect on the practical use of present techniques in the future is discussed. The way in which the megasonic-cleaning

technique works to remove nano-scale particles from flat and structured surfaces is presented. [C3040]

"Nano-photonic-device technologies for ultra-small and ultra-fast all-optical devices-Fusion of photonic crystals and quantum dots -"

Simulation, fabrication, characterization of two-dimensional photonic crystals and fabrication of nanoprobe-assisted site-controlled quantum dots for large optical non-linearity are presented for photonic crystal and quantum dot-based ultra-small and ultra-fast all optical switches [C3041]

"Technology options for developing manufacturable non-silicon nanoelectronics"

The future of silicon based microelectronics in general and computing in particular often raises the question of what will come after silicon complimentary metal-oxide-semiconductor (CMOS) circuits. We have examined all of the currently explored options and found that none of these options are suitable as silicon CMOS replacements. We propose a diamond based metal-insulator-field effect transistor (MISFET) on silicon substrate as the answer to the needs of future electronics. A novel processing scheme based on the direct writing of diamond in nano-dimensions ([C3042]

"Effect of milling process on the magnetic properties of FIB patterned magnetic nanostructures"

Summary form only given. There has been much interest in nano-patterning of hard and soft magnetic materials and perpendicular recording media using the FIB technique, but very few of them has been focused on the milling process and its effect on the magnetic properties of the patterned nanostructures. In this work, the FIB patterning of commercial post-sputtering longitudinal media has been performed with emphasis on how the redeposition would affect the morphology of the patterned structure as well as its magnetic properties. The former was studied using AFM and the latter by MFM. [C3043]

"The improved GMR characteristics of specular spin valve by nano-oxide layer formation with mixed gases"

Summary form only given. The enhanced MR ratio of over 10% and good thermal stability are strongly required for spin valve (SV) used in a read head in order to realize ultrahigh magnetic recording density beyond 40 Gbit/in². Recently, very applicable SVs with a pinned layer containing a nano-oxide layer (NOL) were suggested as a new technology for the improvement of MR ratio, where NOL enhances specular electron scattering. Several oxidation methods for NOL have been studied on the NOL interface control and MR improvement. Of these, plasma oxidation and ion beam oxidation can be hard to control the formation rate of very thin NOL. Accordingly natural oxidation is a good way to control the formation rate because of low oxidation rate. However, we found that natural oxidation in pure O₂atmosphere did have a good reproducibility in our experiments. In order to improve the reproducibility of uniform NOL, we have investigated the natural oxidation conditions by mixed gases (O₂/N₂and O₂/Ar) for the NOL formation. The SV samples used have the structure of Ta(5 nm)/NiFe(2.5 nm)/IrMn(7 nm)/CoFe(2.5 nm)/NOL/CoFe(1.5 nm)/Cu(2.6 nm)/CoFe(1.5 nm)/NiFe(4.5 nm)/Ta(5 nm). [C3044]

"Effect of edge structure on switching of patterned elements"

Summary form only given. The effect of the edge structure on patterned nano-elements is known to have an effect on the switching mechanisms of such thin film elements. In this paper we present results from experimental studies of elements with different edge structures and compare them with simulations performed on a commercial micromagnetics package. Acicular elements with straight and structured edges were fabricated to determine the role of the edges in the switching mechanism. The permalloy (Ni₈₀Fe₂₀) elements described here had width 250nm, length 2.0μm and thickness 30nm. The ends of the elements were tapered to reduce strong demagnetisation effects and suppress domain wall formation. For elements with structured edges both the edge structure height and period were varied. [C3045]

"Photonic bandgap based designs for nano-photonic integrated circuits"

Photonic crystals are artificial crystal structures that do for electromagnetic waves what a semiconductor crystal does for electron waves. Electronic semiconductors are the basis for the micro-electronic, telecommunications, and computer industries, but photonic crystals are distinct, they are the electromagnetic analog of a semiconductor crystal. They have been conceived for various applications including high capacity optical fibers, color pigments, and especially nano-photonic integrated circuits that might become part of standard microchips. [C3046]

"Digest of Papers. Microprocesses and Nanotechnology 2002. 2002 International Microprocesses and Nanotechnology Conference (IEEE Cat. No.02EX589)"

First Page of the Article [C3047]

"Adaptive intelligent design and control of nano structured materials"

For nano science and technology it is very important subjects to establish methods of adaptive intelligent {design, control} for nano {material, device} systems. By applying stochastic dynamics mesoscopic material properties, critical properties and control characteristics were derived. Here essential items for the subjects are summarized. [C3048]

"Opportunities at the skin interface for continuous patient monitoring: a development model based on lactate and glucose"

In the search for devices for continuous monitoring of patients or tissue a great deal of effort has centred on implantable devices. A good example of this is the development of implantable glucose sensors and subcutaneous sensors are currently available with lifetimes of several days. Other implantation systems have been used in the development of artificial retina. Furthermore, there is a large body of microdevice know-how for in vitro measurements such as monitoring of cells on microelectrodes or lab-on-a-chip diagnostics. However, long term implantation of biosensors remains an elusive goal. Unless the active components of a biosensor can be regenerated in situ in the human body, they will always have a limited lifetime. Good possibilities exist for micro and nano technology to contribute to this area through the development of non-invasive, wearable sensors and multi-sensor arrays. The very dimensions of the transmission paths through skin could lend themselves to direct study by miniaturised devices. However, a complete understanding of transmission mechanisms (electroosmosis, diffusion, ion and molecule drift currents) must be incorporated in sensor and device development and calibration for skin use. For example, uncharged molecules may be delivered through skin by electroosmosis due to convective solvent flow, but once through the skin the molecules arrive at the sensor surface by diffusion. This diffusion must take place in a suitable conducting hydrogel which will provide both the skin-hydrating contact and the current path from the iontophoresis electrodes. [C3049]

"Mechanism and modeling of ring pattern formation for electron beam exposure on zwitterresist"

The first application of simultaneous patterning technology on positive and negative tones in lithography has been reported previously. In a further study, we find that the relationship between the applied doses and the obtained ring width does not exhibit linearity, irrespective of the design radius in the center dot. The observation suggests that the assumption of only using the scattering effect in explaining the ring width needs to be improved. At higher electron doses, the heating effect from center area also plays important role. [C3050]

"Molecular dynamics studies on mechanical properties of carbon nano tubes with pinhole defects"

In this paper, the mechanical properties with defected carbon nano tube (CNT) by pinhole defects are studied by molecular dynamics study to investigate influences to the yield strength and vibration properties for multiple defects of CNT. [C3051]

"Position-controlled carbon nanotube FETs fabricated by CVD synthesis using patterned metal catalyst"

Carbon nanotube (CNT) devices receive much attention from both physical and technological points of view because of the ideal one-dimensional structure, nano-size dimension, and ultra-low power dissipation. In order to realize CNT integrated circuits, it is important to fabricate CNT field-effect transistors (FETs) at designed positions. In this work, we fabricated position-controlled CNT FETs by chemical vapor deposition (CVD) synthesis using metal catalysts patterned on a silicon wafer. Good FET operations have been obtained. [C3052]

"Multilayer bottom antireflective coatings for high numerical aperture and modified illumination exposure systems"

In the recent ITRS roadmap, ArF and F2excimer laser lithographies combining with resolution enhancement techniques would lead IC technologies to generations of 90 nm and 65 nm, respectively. For increasing resolution of optical lithography, expose systems with high numerical aperture (NA) are essential. The efficiency of the conventional single-layer BARC structure will degrade as the incident angle increased. It is due to the reflectance at resist/BARC interface increases in the large incident-angle regime. Here we demonstrate a

multilayer bottom antireflective coating (BARC) layer for high-NA exposure systems in ArF and F2 lithographies. [C3053]

"A macro-micro motion system for a scanning tunneling microscope"

As nano-lithography technology improves, more companies and research groups have the capability to create nano-scale structures. Scanning tunneling microscopes (STMs) are commonly used to create these structures and evaluate them afterward. One difficulty is that these nanostructures are difficult to find on a one centimeter-size die cut from a silicon wafer without very specialized hardware and post-processing and analysis. The National Institute of Standards and Technology (NIST) is conducting research into developing a macro-micro motion system that would allow these nano-structures to be more effectively located and identified on the die. An XY stage system using linear piezo-actuators can perform the macro motion by moving the sample to where the STM tip can scan a particular region of the die to make an analysis. The STM tip would then perform the micro motion by scanning the region for the nano-structure. A vibration isolation system has been designed for this macro-micro motion system using springs and eddy current dampers. This vibration isolation system will isolate the entire system from the outside world and the individual components from each other. A high-precision interferometer system is also installed to independently monitor a flexure driven stage for the STM tip. A graphical programming system was developed for controlling the motion of the STM tip. All of these systems combine to form the initial steps toward coordinated closed-loop control of the STM. [C3054]

"Prospects of advanced quantum nano-structures and roles of molecular beam epitaxy"

Over the last three decades, layered nano-structures, such as superlattices (SLs) and quantum wells (QWs) have played notable roles in expanding the forefront of physics and electronics. The births and advances of QW lasers, selectively-doped heterojunction FETs (HEMTs), and related 2D electron devices, for example, have made huge impacts in various branches of information technology. One should note that all of these nano-structures were first realized by molecular beam epitaxy (MBE) that permitted the formation of atomically flat and abrupt hetero-interfaces. This marvellous success of MBE has then inspired related attempts in other research areas, inducing breakthroughs in such fields as magnetic and superconducting materials and devices. [C3055]

"Si nanowires growth catalyzed by TiSi₂ islands in gas-source MBE"

As devices in modern integrated circuits become smaller and smaller, the fabrication process become increasingly expensive, and sub-100nm feature sizes become difficult to produce. New nano-scale self-assembling technology, such as catalyzed nanowires growth and quantum dot growth, may benefit integrated-circuit production by eliminating critical lithography step. In these self-assembled systems, small features are formed using chemical reactions and/or crystal growth with limited or coarse lithography. Using TiSi₂ islands as a catalyst, we have grown Si nanowires in molecular-beam epitaxy (MBE) using Si₂H₆ as a gas source. Approximately one monolayer of Ti was deposited on Si[001] wafers at 500°C and then annealed above 800°C to form TiSi₂ islands. The Si nanowires were then grown at 500°C using Si₂H₆ gas as the Si source. [C3056]

"Advanced sensor technologies for micro- to nano-scale biological measurements"

In cell biology research, the scale of the system limits the utilization of traditional electroanalytical microsensors to study the biological activity of single cells. The application of electroanalytical microsensors to this research can be broadened by developing new technologies. This includes the application of the principles of the vibrating (self-referencing) ion-selective microelectrode to the operation of these types of sensors. This involves fabrication and testing of advanced electroanalytical microsensors, and the development of a self-referencing electroanalytical microelectrode (SREM) instrumentation platform. SREM sensors have been developed for analytes such as oxygen, nitric oxide, and ascorbic acid (vitamin C). All of these sensors have demonstrated a high level of sensitivity and spatial resolution. This approach has been validated against nonbiological microscopic flux sources that were theoretically modeled before being applied to isolated single cells. These new sensor technologies have been shown, through research in a wide variety of biological and biomedical research projects, to be an important new tool in the arsenal of the cell biologist. Recently this SREM technology has also been adapted through the development of SREM-H₂O₂ and SREM-NADH sensors to support the use of electrochemically coupled enzyme based biosensors. Based on this self-referencing biosensors (SRB) for glucose and ethanol have been developed and have undergone validation testing in artificial systems. These developments in self-referencing sensor technologies offer great promise in extending the application of electroanalytical and biosensor technologies from the micro to the nanoscale. [C3057]

"Displacements and rotations of practical vibrational modes of piezoelectric bimorph cantilever beams"

Piezoelectric ceramic bimorph flexure beams are essential elements in micro- and nano-technology sensors, devices and systems, such as optical deflectors and modulators. Mode shape depends on drive frequency, so it is possible to adjust the shape to optimize a particular performance function. Two configurations are of particular practical importance for MEMS (micro-electro-mechanical structure/system) and MOMS (micro-opto-mechanical structure/system) sensor applications: the free end of a fixed-free cantilever resonator adjusted to translate without rotation, and to rotate without translation. Using simple Euler-Bernoulli beam theory applied to a piezoceramic bimorph configuration, expressions are found for beam displacement and slope as function of frequency. Relevant parameters are tabulated at frequencies of Rayleigh resonance and the piezo-antiresonances of zero displacement and slope, with numerical examples. [C3058]

"MIDS: micro input devices system using MEMS sensors"

The evolution of human-to-computer input devices lags far behind the evolution of processing power. In this paper, we present work on merging MEMS force sensors and existing wireless technologies to develop a novel multifunctional interface input system, the Micro Input Devices System (MIDS), which could potentially replace the mouse, the pen, and the keyboard as input devices to the computer. Moreover, initial experimental results indicate that further exploration of this technology could eventually produce a new control-input device for grasping robotic manipulators. We have thus far developed a prototype MIDS that consists of two MIDS rings, each packaged with commercial MEMS acceleration sensors to sense multi-axes motion, and a MIDS wrist watch that communicates with the rings and transmits data wirelessly to interface with a CPU. The system has been demonstrated to perform click and drawing motions successfully. A self-calibration method was also developed to resolve ambiguities in sensed motion for the MEMS sensors. [C3059]

"Artificial intelligence based measurement system supervision"

The permanent increasing of quality standards, world wide competition, as well as the legislation of regulation of the product responsibility, require not only a proper documentation of the measurement data of the production, but also the continuous supervision of measuring and test equipment. Especially in modern flexible and intelligent production environment, measuring devices are often connected directly with the manufacturing process. This causes direct or indirect influences on the quality level, therefore the supervision and management of measuring and test equipment is becoming a significant part of the quality management for the entire production. The supervision of measuring equipment is an essential quality requirement for modern production especially at the higher demands of micro and nano technology. The efficiency of the confirmation can be increased and expenses can be reduced substantially through computer assistance with flexible checking intervals. A special method developed for this purpose allows to increase of the flexibility level and efficiency of a system for the intelligent management and supervision of measuring devices. [C3060]

"Non-Coherent Infrared Light: a new high speed transmission technology targets for applications in intelligent transport-systems (ITS), corporate communications and nano-cellular services"

The paper describes the medium of "Non-Coherent Infrared Light" as a viable "high speed" alternative to radio-LAN technologies for communications between vehicles and the roadside infrastructure respectively between vehicles. The overload of the radio-spectrum on the one hand and the virtually unlimited bandwidth of infrared light as well as the absence of regulations and licensing cost in most parts of the world on the other hand make infrared the ideal choice in ITS as well as in corporate communications systems for distances up to a few hundred meters at bandwidths up to 500 Mbps and more. The properties and limitations of infrared light in an ITS-environment are the main subject of the paper. Examples of implemented systems are given, too, as well as the standardisation process in progress. [C3061]

"On-line testing of multi-source noise-induced errors on the interconnects and buses of system-on-chips"

With processors and system-on-chips using nano-meter technologies, several design and test efforts have been recently developed to eliminate and test for many emerging DSM (deep sub-micron) noise effects. In this paper, we show the emergence of multi-source noise effects, where multiple DSM noise sources combine to produce functional and timing errors even when each separate noise source itself does not. We show the dynamic nature of multi-source noise, and the need for on-line testing to detect such noise errors. We propose a double-sampling data checking based low-cost on-line error detection circuit to test for such noise effects in on-chip buses. Based on the proposed circuit, an effective and efficient testing methodology has been developed to facilitate online testing for generic on-chip buses. The applicability of this methodology is demonstrated through embedding the on-line detection circuit in a bus design. The validated design shows the effectiveness of the proposed testing methodology for multi-source noise-induced errors in global interconnects and buses. [C3062]

"Jetting technology: a way of the future in dispensing"

One method used in current printed circuit board assembly is attaching components to the board with a surface mount adhesive (SMA). A small dot of adhesive is placed between two pads. Passive components i.e., 0402 can be attached to the board by jetting small dots of SMA material. The component is then placed on top of the SMA. The SMA is then cured, fixing the component in place. The experiment described in this paper attempted to reach a measure of dot size using SMA and silver epoxy materials. Small dot jetting has additional leading edge applications. The present work shows the capability of jetting material in volumes of about 3 nano-liters. The underfilling of 3D-packages with small gaps that are required to accomplish thin packages, as well as the underfilling of small die present yet another challenge to the consistency and accuracy of dispensing processes. This paper addresses the underfilling of 3D stacked die by jetting material on die surfaces with small dots to accomplish gaps of just a few microns. The challenge of jetting, abrasive materials is addressed here by monitoring, wearout evolution on the jet itself and corresponding effects on the jetted fluid characteristics. Analytical work on the fluid dynamics is presented and its predictability is demonstrated by experimental data.

[C3063]

"High density packaging in 2010 and beyond"

As microsystems continue to move towards higher speed and microminiaturization, the demands for interconnection density both on the IC and the package increases tremendously. With the shift towards nano ICs by 2003 with 100 nm features, pitch of area array I/Os of the nano ICs will move towards 20-100 micron. Increasing system functionality and system-on-a-chip will place demands on the package to support extremely high digital clock speeds beyond 5 GHz, RF signals to 40 GHz, and optical data rates beyond 100 Gbps all on a single, highly integrated package or board. A completely new paradigm shift in high density packaging is required to meet these complex requirements. Current trends both in IC and systems packaging including SIP, wafer level packaging are steps in the right direction, but represent partial system solutions. The Packaging Research Center at Georgia Tech has been developing system-on-a-package (SOP) technology to integrate digital, RF, and optical, all on a multi-function, microminiaturized board. This paper reviews systems, IC, and high density packaging trends and summarizes the latest PRC developments in high density SOP packaging technology.

[C3064]

"Self alignment technology between microlens focal points and near-field optical nano-probe apertures in 2-D micro-optical disk head"

A new optical memory system is urgently required to realize larger memory capacity and faster data transfer rate for the coming higher speed internet era. To overcome the current capacity barrier and the current low data transfer rate barrier in the far-field optical techniques, a novel near-field optical memory of super-parallel evanescent waves has been proposed and is being developed using a vertical cavity surface emitting laser (VCSEL) probe array, which consists of the VCSEL array as a light source and the GaP probe 2D array as the evanescent wave efficient generator. Fabrication and estimation of higher optical throughput for GaP probe array are described with 1.25% high throughput efficiency adopting a newly developed microlens array between the VCSEL output windows and the each GaP nano-probe in the array, where the focal points of each microlens inside the each semiconductor nano-probe are exactly coincident by the newly developed self-alignment technology. An array of up to 10,000 elements had been prepared successfully using the newly developed micro-fabrication processes, including the nano-photolithography, dry etching with ion milling and reactive ion etching processes, and the AR-coating deposition process to the high refractive index material surfaces. [C3065]

"Design and fabrication of high aspect ratio fine pitch interconnects for wafer level packaging"

The Packaging Research Center (PRC) at Georgia Tech has been exploring and evaluating novel compliant nano interconnect designs to enable high density I/O architecture for the next generation chip assembly. Most of the compliant interconnects that are currently being developed have inductance and resistance higher than desirable. We propose high aspect ratio interconnects as a solution that can support both electrical and mechanical requirements. The fabrication of these interconnects is similar to the standard IC fabrication and involves only one additional step beyond the standard CMOS wafer processing, thus making it a cost effective wafer level process. Extensive modeling was carried out to design 40 μm pitch interconnects with optimized electrical and mechanical properties. The fabrication of fine-pitch copper interconnects with aspect ratio of 1:5 was demonstrated as a low-cost wafer level process. Results show that these interconnects provide the optimal combination of electrical and mechanical requirements and hence provides a viable solution for next-generation electronic packaging that can support extremely high I/O density. [C3066]

"Conference Record of the Twenty-Ninth IEEE Photovoltaic Specialists Conference 2002 (Cat. No.02CH37361)"

First Page of the Article [C3067]

"Development of nano-surgery system for cell organelles"

A nano-surgery system has been developed for operation of minute organelles in a cell. such as chloroplast and mitochondria. For the operation, nano-pipettes, nano-manipulators, sample stage, and bellows pump were fabricated. It has been succeeded to prick a chromosphere in a plant cell and the membrane just under the nucleus of an animal cell with the tip of nano-pipette and to inject fluorescent dye into these organelles. [C3068]

"Structure properties of cubic-AlN grown by reactive gas-timing rf magnetron sputtering"

The structure properties of aluminum nitride (AlN) thin films were investigated by X-ray diffraction (XRD) and field emission scanning electron microscope (FESEM). Using rf magnetron sputtering, the reactive gas-timing technique was successfully applied to grow cubic-AlN thin films. The XRD patterns of all deposited AlN films showed orientation of cubic structure in [111] and [200] planes. The lattice constant and grain size were calculated and correlated with the flow rate of N₂gas. The FESEM images showed the surface morphology of nano-particles. The nanocrystalline AlN particle sizes increased with increasing flow rate of N₂. [C3069]

"Manufacturing and characterization of nano-sized PbTe powders"

Nano-sized PbTe powders were manufactured by the high energy ball milling of a PbTe bulk, obtained by the water quenching of a melt. The wet milling using an ethanol were applied during the ball milling. The prepared powders were characterized by the X-ray powder diffraction pattern analysis to obtain crystallographic parameters such as the crystallite size and the misfit strain. A pseudo-Voigt function was used for the determination of the integral breadth and the full width at half maximum (FWHM) of peaks broadened by the effect of crystallite size and misfit strain. The Scherrer method, the Williamson-Hall plot and the single peak analysis were employed to calculate the size of crystallite and misfit strain with the consideration of instrumental broadening using standard sample. As results, we can observe the tendency that the crystallite size decreases and the misfit strain increases with increasing milling time. The crystallite size of powders was determined at the range of 15 100 nm in 50 150 hours milling time. The crystallite size and the misfit strain were different from crystallographic directions in this material, according to the Williamson-Hall plot and the single peak analysis. [C3070]

"Fabrication of high accuracy micro-translation-table for near-field optical data storage actuated by inverted-scratch-drive-actuators"

In recent years, development of a next generation high-density recording system has attracted an increasing attention with the improvement of the storage density. One of the attractive technologies to overcome the limit of the storage density is near-field optical data storage. The optical memory with high density and high data transfer rate is highly demanded to utilize an array of nano-scaled light sources for writing and reading bits formed on a recording medium. We have fabricated a micro-translation-table to convey the recording medium to the near-field optical head. The proposed micro-translation-table consists of the inverted scratch drive-actuators (SDAs) which are electrostatically driven. The inverted SDA is powerful and precise due to the stepwise movement. A long distance translation is achieved by repeating the stepwise movement. Fast moving speed, high response and the positioning resolution of the order of 1 nanometer are possible. The inverted SDA has been fabricated with silicon surface micromachining technology. We have proposed a novel mechanism that the SDAs can be retracted to a substrate by applying the voltage between the SDA and a lower electrode. Therefore, the SDAs used for the conveyance are stretched and others are retracted. We have observed that a micro object is translated with the fabricated actuators by applying AC voltage of 600 V at 100 Hz. [C3071]

"Nano bio-injector fabrication by focused-ion-beam chemical-vapor-deposition"

The degrees of freedom in designing their shapes will be a great advantage in Focused-Ion-Beam Chemical-Vapor-Deposition (FIB-CVD), as we previously demonstrated with several three-dimensional nanostructures, i. e., wine glasses, coils, and pillars. Moreover, a very large Young's modulus were confirmed by observation of DLC pillar mechanical vibration. These characteristics are very useful for various biological devices. We will report fabrication of Nano Bio-Injector by using FIB-CVD. [C3072]

"Fabrication of nano electron source using beam assisted process"

Fabrication of a field emission electron source is a basic technology for vacuum micro electronics. There are various types of field emitter such as Spindt-type, Si-type, etc. Most of the electron sources have been fabricated using semiconductor process. In this study, a nano electron source has been fabricated using beam-assisted maskless processes. These processes use physical and chemical, reactions by electron beam (EB) or focused ion beam (FIB) with a Ga liquid metal ion source, moreover, a gate diameter and an emitter height can freely be fabricated using these processes. [C3073]

"Bovine-serum-albumin capped gold nanoparticles as bio-mimic system for the stereo-specified recognition of Dansyl-derivative amino acid"

Recent activities of biochemistry as well as pharmaceutical research areas developed the use of Self-assembled Monolayer (SAM) technology to generate monomolecular films of biological molecules (e.g. proteins, enzymes, nucleic acids and carbohydrates) on various substrates. The formation of such monolayer systems is extremely versatile and can provide a method for the in-vitro development of bio-surfaces, which are able to mimic naturally occurring molecular recognition processes. A kind of bio-macromolecules named Bovine-Serum-Albumin (BSA), which is composed of asymmetric units (L-amino acids), is a versatile transporter protein. The primary function of BSA is carrying small molecules around the blood stream. In this work, the SAM of BSA on gold nanoparticles capped silica gel (5 μm) and treated as chiral selector for enantiomeric recognition of Dansyl-derivative amino acid. [C3074]

"The novel nano-fabrication technique with low edge roughness"

This paper demonstrates the novel nano-fabrication technique usable in the mass-production with low cost and high through-put.. The F2stepper and the electron beam stepper are expected as future technologies for sub-0.1 μm node. However, such a stepper costs as much as about \$ 20,000,000. Nano-scale devices such as a single electron transistor are sometimes fabricated by using a tip of an atomic force microscope (AFM). However, it does not appear as an industrially acceptable technique. Hence, if a novel method utilizing only conventional photolithographic technique is developed for nano-size fabrication, it surely opens the new stages. For its purpose, we have developed a new method, in which a contact patternmask with nanometer-size slits (nanometer slit mask) is fabricated by combining the conventional photolithography and anodic oxidation. [C3075]

"Microfluidic mixer devices fabricated using high-aspect-ratio glass micromachining technology"

Glass is a preferable substrate material for BioMEMS or LOC (Lab-on-a-chip) since it has good chemical and thermal stability and transparency. Conventionally, however, wet chemical etching has been utilized in microfabrication of glass plates, and hence it was impossible to fabricate precise and/or high-aspect-ratio microstructures. In the last two years deep dry etching technology of quartz and borosilicate glass has been developed using high-density plasmas and metal masks. In this paper feasible and reliable fabrication process of multilayer microfluidic devices and micromixers has been studied, which are useful for rapid and parallel operation of plural reagents. [C3076]

"Nanophotonics: the breakthrough technology to control nanostructure by photons with near field and nonlinear optics"

Summary form only given. The minimum size of the light spot generated with traditional optics is around a half micron. In this presentation, I will show how we can exceed this limitation due to the diffraction of the light with an evanescent photon, which has an imaginary momentum component to tunnel in the near field between nano-probe and nano-structure. Nonlinear response of the material to photon intensity can be also used for super-resolving imaging. I will show our experimental results from our developed near-field Raman imaging/spectroscopy, coherent anti-Stokes Raman microscopy, and two-photon photo-polymerization and photo-isomerization for fabrication, manipulation and observation of nano structures. [C3077]

"GaAs microcrystal growth and its position control by low energy focused ion beam"

GaAs microcrystal growth and its position control was demonstrated using a low energy focused ion beam system to fabricate the photonic crystals. Due to the rapid progress in ULSI design and the trend in high density packing, in the near future, the Al or Cu based interconnection system will face a difficulty in the signal flow. For this purpose, the photonic crystal and its application to the optical signal transfer system has been intensively studied. In this system, a crucial point is how to fabricate the ordered and controlled structure which has higher dielectric constant. For this system, imbedded GaAs microcrystals in SiO₂ are thought to be the best candidate. But the challenging is the position controlling of the GaAs microcrystals. For this purpose, we demonstrate the

array of GaAs microcrystals on Si(100) surface with As-termination method. [C3078]

"Diluted low dielectric constant materials as bottom antireflective coating layers for both KrF and ArF lithography"

For reduction interconnect signal delay, low dielectric constant (K) materials are being introduced to replace conventional dielectrics in next generation IC technologies. In the advanced lithography processes, a bottom antireflective coating (BARC) layer for patterning low-K materials is essential. Nitride-based (silicon nitride, silicon oxynitride) films have been demonstrated to have suitable optical characteristics for both KrF and ArF lithography BARC applications. However, dielectric constants of nitride films are about 4–8. Therefore, the nitride films should be removed after patterning low-K materials. Here we demonstrate low-K materials for both KrF and ArF lithography BARC applications. The antireflective layer is composed of diluted low-K materials, such as BCB, FLARE, and SiLK. [C3079]

"Micro-mirror array control of optical tweezer trapping beams"

The lack of tools to manipulate nanoscale objects is a major obstacle to fabricating and testing nanodevices. Optical tweezers are a promising tool for nanomanufacturing, but the efficiency of optical tweezer manufacturing depends on the number of trapping beams available. Micro optics technology offers the opportunity to significantly increase the number of trapping beams without a significant increase of the cost or size of the optics. Here we report on the sensors, optical circuit and the experimental work to control an array of laser beams generated by a single laser diode, for optical-tweezer-based nanomanufacturing. Our array of laser beams is generated by an array of servo controlled scanning dual-axis micro-mirrors. Capacitor electrodes underneath the micro-mirror plates provide electrostatic actuation, which allows control of the micro-mirror position. With proper reflecting surfaces it is possible to control the impact angle of the individual laser beams onto the micro-nano-particles, thus generating an optical beam gripper effect. [C3080]

"Techniques and methods for the simulation of nanoscale ballistic MOSFETs"

In this paper, we present the methods and the techniques we use for performing the simulation of nanoscale ballistic MOSFETs in bulk silicon, silicon on insulator, and silicon-germanium. Results for typical structures with channel length of 25 nm are presented. [C3081]

"Piconewton regime measurements of biomolecular interactions by nanomechanical force gauge"

A piconewton regime measurement of biomolecular interactions in an aqueous solution by a novel nanomechanical force gauge (NFG) is presented in this paper. A highly sensitive nanoscale cantilever with a spring constant, which is thousand times smaller than that of an atomic force microscope (AFM) microcantilever, is fabricated by a batch process. The NFG has a capability of direct reading without any optical amplification. The control of nanoscale thickness of a single crystal silicon cantilever is done by a thermal oxidation process. The deflection of the cantilever, corresponding to piconewtons is directly measured by reading the tick movements in the reading scale of the NFG under the microscope. The spring constant of the NFG is calculated by identifying the natural frequency using electrostatic force excitation, and the minimum value of the designed device was 78.6 pN/μm. As an example of the biomolecular applications, the dissociation between a biotinylated bead and avidins is measured, and the mean is 636 pN. The NFG has the potential of 1 pN/μm sensitivity through the nanofabrication technology as well as serving as an inexpensive and powerful substitute for an atomic force microscope in studying biomolecular interactions. [C3082]

"Gene expression modelling with the use of Boolean network and artificial neural network"

Recent progress in molecular biology has enabled exploration of the mechanisms of genetic information processing in organisms. With the use of new technologies it is possible to observe a state of the cell at different time steps, assemble and disassemble genetic information carriers, etc. With new tools available there is a chance to answer the question that has motivated our predecessors. There is a chance to find out "how it all works?" In this paper we study a method of gene networks modelling. A gene network is a mass of genes interacting with one another through expression. The model is used to infer a gene expression mechanism on the basis of gene expression measurements. In our approach we employed two network models: a Boolean network model and an artificial neural network model. We have shown that large data can be handled efficiently with the aid of already developed methods and algorithms. Thanks to them, drawing meaningful inferences from large gene expression data may be converted into simple tasks. [C3083]

"Fabrication of ultrahigh-density nano-pyramid arrays (NPAs) on [C100] silicon wafer using

scanning probe lithography and anisotropic wet etching"

Convex and concave nano-pyramid arrays (NPAs) with an areal bit density of 64.5 Gbits/in² has been demonstrated by means of scanning probe lithography (SPL) and wet etching on the [100]-orientation silicon wafer. First, we investigated the use of a contact-mode atomic force microscope (AFM) in the generation of oxide patterns on silicon [100] surfaces. Subsequently, utilizing the oxide pattern as Si etching masks, the Si substrate was dipped in aqueous KOH solution, where un-oxidized regions were selectively etched by aqueous KOH orientation-dependent etching (ODE). Using this simple process, 20 nm convex NPAs with 100 nm pitch can be fabricated successfully. Similarly, about 2 nm concave NPAs with 100 nm were obtained after the oxidized samples were dipped in aqueous HF solution, the oxide regions were selectively etched away. To demonstrate the capability of this technology, we have showed an AFM micrograph of the letters "TLS". These patterns correspond to an ultrahigh data-storage density of about 64.5 Gbits/in², more than 20 times increase in areal density compared to conventional optical recording. We also demonstrated that the minimum size of the pyramids and the minimum pitch could be easily controlled by the apex size of the pyramid, that is, the size of the oxidized region by AFM-based field-induced oxidation. The results indicated that this technique has potential to provide a pathway to the higher densities that will be needed in the decades ahead. Also, the influenced parameters of oxide pattern and the influence of wet etching on etching rate and shape of etched structure will be discussed. [C3084]

"Towards the design of programmable self-assembled DNA-carbon nanotubes: an approach to nanobiotronics"

Recently, bioelectronics has become a unique fusion of ideas leading to the development of new bio-devices, which electrically interface biological compounds such as proteins, lipids, and DNAs with electronic transducers. The major developments in this research field are biosensors and biomaterials. In addition, recent trends in interdisciplinary studies in chemistry, biology and electronics have led to a new field of research: biomolecular electronics. This promising scientific field is part of a more general approach, molecular electronics, which aims to the development of new electronic technologies, and will overcome the problem of downscaling silicon CMOS electronics faces, having the long-term goal of building a molecular computer with highly reduced feature sizes, higher performance and increased information processing capabilities. In this preliminary work, we propose a new approach for the realization of a programmable bio-molecular units that will take advantage of the self-assembly and selectivity properties of DNA molecules and the versatility of carbon nanotubes (CNT) to build scalable computing systems that will prove the feasibility of the biomolecular computer. [C3085]

"Narrow-width SOI devices the role of quantum mechanical space-quantization effects on device performance"

We investigate the role of quantum mechanical space-quantization effects on the operation of a narrow-width SOI device structure. The presence of a two-dimensional carrier confinement gives rise to larger average displacement of the carriers from the interface proper and lower sheet electron density in the channel region. This, in turn, results not only in a significant increase in the threshold voltage but also in pronounced channel width dependency of the drain current. In this work, we have used classical 3D Monte Carlo particle-based simulations. Quantum mechanical space-quantization effects have been accounted for via an effective potential scheme that has been quite successful in describing bandgap widening effect and charge set back from the interface. [C3086]

"New technology for the manufacturing of nanocrystalline materials"

For the manufacturing of nanocrystalline materials have been developed several methods. One of the methods is based on fabrication of a metal-organic or a complex compound using appropriate metal salt solutions or their melts. Pyrolysis at 800-900°C of an appropriate compound in hydrogen atmosphere obtains a charge of carbide or already fabricated hard metals. The second method is based on the manufacture of complex compounds and their further carbidization, using the gaseous phase. Complex compounds of optimum composition as well as a carbide making atmosphere give rise to the formation of nanocrystalline carbides and hard metals at 700-800°C. [C3087]

"A frequency-selective terahertz radiation detector based on a semiconductor superlattice with a resonator"

We propose the new design of the terahertz detector, which must have frequency selection property and operate at room temperature. The idea is based on a standing wave enhancement of detector responsivity. The detector contains lateral semiconductor superlattice, broadband bow tie THz antenna and THz resonator. As compared with well-known variant we change a technology of antenna attachment to the superlattice that allows

additionally growing up THz resonator. We performed numerical analyze of the structure based on the relaxation time approximation of electron transport in superlattice and wave line description for matching between antenna and superlattice. We choose the superlattice parameters, which are technically available today and show that the detector responsivity can be enhanced several hundred times in comparison to well known existent variants of a such detector, also the frequency selection quality can achieve a very high value (F/F_{103}). [C3088]

"Plasmon coupled tip-enhanced near-field optical microscopy"

Scanning near-field optical microscopy aims at optically resolving subwavelength structures. The most common technique relies on the local excitation of the sample surface by the optical fields near a nano-aperture which is commonly produced at the end of a glass fiber tip. Alternatively, high resolution microscopy can also be achieved by using the local field enhancement produced at the end of a sharp metal tip when illuminated by a highly focused laser beam. By combining these techniques in the form of a sharp metal tip at the end of an overcoated fiber, we propose a new method that does not require the delicate technologies to produce nano-apertures, nor require the intense external focused beam responsible for the field enhancement. [C3089]

"Progress and prospect of quantum dots and photonic crystal for future photonic network devices"

Broadband and wireless network will play key roles toward the ubiquitous information society in which people communicate each other at anytime and anywhere in the 21st century. For the broadband and wireless communication network, photonic network device will be the most important as an infrastructures, innovation of the network devices is significantly required. In particular, development of semiconductor nano-devices will be indispensable in order to achieve efficient communication networks of high-performance. The nano-devices are based upon various nanotechnologies including quantum dots (QDs), photonic crystals, and nano-scale controlled interface of emerging materials such as III-Nitride and organic semiconductors. Moreover, integration of those nanostructures together with MEMS technology is very promising for future photonic devices. In this paper, we first briefly discuss the ubiquitous information society, indicating a paradigm shift from one-to-one communication to complex community where everything is tightly connected each other through networks. Prospect and direction of broadband and wireless technologies based upon the nanotechnology will be addressed. Then, we discuss our recent progress in semiconductor nanostructures including quantum dots (QD) and photonic crystal (PC) for broadband photonic network devices. In addition, impact of optical MEMS integrated with nano-devices for various unique functions and performance is addressed. [C3090]

"Preparation and characterization of nano-sized TiC powder by DC thermal plasma"

Titanium carbide has excellent properties such as high melting point, high strength, high wear resistance, low thermal expansion coefficient and lightweight. We have developed a thermal plasma process for synthesis of high quality nano-sized TiC powder. [C3091]

"Quantum extension of Child-Langmuir law"

Summary form only given, as follows. In the advent fields of nano-technology, electrode gaps with scales down to nanometer regime can be fabricated. On such a nano scale, quantum effects such as electron tunneling and the electron exclusion principle become important in the study of beam-gap interaction. We extend the classical Child-Langmuir law into the quantum regime including the effects of electron tunneling and the electron exclusion principle for various geometrical electrodes. By using local density approximation, we introduce an exchange potential term in the time-independent Schrodinger equation to account for electron exclusion principle. Our results shows that the limiting current density is higher when exclusion principle is included, and it is more significant when the applied DC gap voltage is smaller than the Hartree energy (EH). Our model shows that limiting current is increased by a large factor when the gap spacing is on order of electron de Broglie wavelength (at energy equals to gap voltage). Geometrical effects of the electrodes are investigated by extending our one-dimensional planar model to cylindrical with one set of parameters used to infer the results expected for other sets of parameters. Further application and implication of this work is discussed. [C3092]

"Nanotechnologies and nanosystems of informatics as a basis for self-replication"

If basic elements applied in given technology are single atoms or molecules, then this technology is named nanotechnology. If basic elements of codes used in the given system of informatics are single atoms or molecules, then such a system of informatics is called nanosystem of informatics. Recent research on the nanotechnological processes of molecular products and objects synthesis as well as research on the nanosystems of informatics stimulate development of the technical systems of informatics. Until now, the latter have been used mainly for the computational tasks, when similarly to biological organisms, they allowed for development of self-replicating products and complete objects. One can focus here on the model of a circulation

of materials, information and energy in a biological cell, and a model of the self-replication phenomenon. In the model of materials, information and energy circulation, we may distinguish a two-stage process of creating products, which are later on used for objects construction. The first stage is a translation process based on information from mRNA, while the second stage is a phase of post-translational modifications based on environment interaction. The self-replication model presented in this paper refers to a self-replication of a material object together with its internal software, which had determined object's creation. Presented models of materials, information and energy circulation in a biological cell together with models of self-replication phenomenon can be the basis for a design and development of the technical systems of informatics capable to create the self-replicating products and objects. [C3093]

"Electron transport in nanoscale bipolar transistors"

As base widths are reduced to tens of nanometers in modern bipolar transistors, current transport becomes quasi-ballistic. Classical transport models do not capture transport at this scale. We report the development of a new one-dimensional bipolar transistor simulator-nanoBJT, to study electron transport in nanoscale transistors. The simulator incorporates a variety of carrier transport models, and solves these self-consistently with Poisson's equation. The resulting data demonstrate the limitations of the drift-diffusion and the energy transport models. Directions for future work are proposed. [C3094]

"Capacitive micromachined ultrasonic transducer based integrated actuator for atomic force microscope cantilevers"

The atomic force microscope (AFM) is a versatile tool for imaging and modifying surfaces on atomic scales. The core of the device is a cantilever beam with a sharp tip. The cantilever usually measures a few hundred microns in length and tens of microns in width. Many imaging or surface modification applications require actuation of this micron scale beam. In this paper, a novel actuation mechanism is introduced. The method uses radiation pressure generated by capacitive micromachined ultrasonic transducers (cMUT). The cMUTs are fabricated on top of the cantilever beams and they operate in the megahertz range generating a DC radiation pressure in the immersion medium such as water or air. The integrated cMUT cantilever system compares favorably with piezoelectric film activated and with non-integrated ultrasonic actuation schemes. The cMUT cantilever does not require any alignment of the actuator to the cantilever. Moreover, it works in air as well as in water and is readily used with parallel cantilever probes. Finally, it is an IC compatible technology solution. [C3095]

"Failure analysis requirements for nanoelectronics"

Failure analysis (FA) plays a vital role in the development and manufacture of integrated circuits (ICs). But instrumental limits are already threatening FA in the tenth-micron CMOS realm, and nanoelectronic scale devices will find key analytical tools two orders of magnitude removed in capability. This paper will introduce state of the art microelectronic failure analysis processes, instrumentation, and principles. It will discuss the major limitations and future prospects projected using industry roadmaps. Specifically highlighted is the need for fault isolation methodology for failure analysis of fully integrated nanoelectronics devices. [C3096]

"Nanoelectromechanical systems and nanomachines: biomimicking and prototyping"

Complex nanoelectromechanical systems (NEMS) exist in nature in enormous variety and sophistication. These NEMS are built from various nanoscale structures, devices and subsystems. Complex nanodevices can be devised and designed through biomimetics. Living organisms and systems, which consist of atoms, molecules, molecular structures and molecular systems can be examined and prototyped using the corresponding theories. The ability of organisms to function in a particular way depends on the presence, absence, concentration, location, interaction, and architectures of integrated structures, components and systems. Bioelectromechanics and bioelectronics are the synergy of science, engineering and technology to compliment and enhance fundamental research and applied developments in complex nano- and microscale systems. For example, one can apply complex biological patents and processes to devise and fabricate nanomachines. Biomimicking can be performed in researching structures, architectures and biological materials of biomolecules, cells, tissues, membranes, biomotors, biosystems, etc. This paper aims to provide a focused study of bioelectromechanics, which is a far-reaching frontier of modern science and engineering. The results are illustrated by devising high-performance transducers (actuators and sensors) via synthesis of novel topologies which are discovered when prototyping bionanomotors. [C3097]

"Static buffered SET based logic gates"

In this paper we investigate single electron tunneling (SET) devices from the logic design perspective, using the SET tunnel junction's ability to control the transport of individual electrons. In SET technology, small circuits

containing only 1 tunnel junction (passive circuits) can form compact circuits implementing complex functions, but suffer from strong feedback effects. To alleviate this problem a dynamic buffer was proposed. However, this dynamic buffer has a behavior similar to a flip-flop and requires additional control signals. Therefore we first propose in this paper a static SET active buffer. The proposed static buffer switches output values by transporting one electron only and operates on a DC supply voltage. Second, we combine the proposed buffer with a threshold gate and derive static buffered NAND and NOR gates. We demonstrate our approach by presenting simulation results for a small network of gates, proving that the gates function correctly under a fanout of 4. [C3098]

"Surface-mounted thin-film actuators in pointing systems applications"

In this paper, high-fidelity modeling, precision positioning, vibration and disturbance attenuations, as well as tracking control problems for flexible beams with thin-film PZT actuators are studied. The mathematical models of the beam are described by partial differential equations. Nonlinear actuator dynamics are integrated to perform design, and guarantee accurate performance analysis with outcome prediction. Forces developed by the PZT actuators are applied to properly position the beam, attenuate vibrations and minimize disturbances. It is illustrated that high-fidelity mathematical models of actuators must be integrated because nonlinearities, hysteresis and other phenomena cannot be neglected. These nonlinear effects significantly degrade overall performance and, therefore, the control problem must be solved. To guarantee the optimal performance, robust tracking control algorithms are designed using proportional-integral control laws with state feedback. A novel design method is applied. In addition to the solution of the tracking control problem, the parametric optimization problem must be examined. In particular, we examine the system performance using different numbers of thin-film actuators and optimize their locations. The results reported are new and have not been previously reported in the literature. The proposed mathematical models, design procedures and optimization are verified through heterogeneous simulations and data-intensive analysis using the MATLAB environment. [C3099]

"Discovery and classification of motion nanodevices"

Enabling technologies have been developed to synthesize and fabricate organic, inorganic and hybrid nanostructures. The fundamental theory has been further expanded to design, model, simulate and analyze simple nanoelectromechanical systems and devices. There are distinguishing features between nanoscale electromechanical systems, devices, and structures. In general, systems integrate nanodevices and nanostructures. However, using commonly used and accepted notations, we assume that the motion nanodevice is a nanoelectromechanical system (NEMS). A spectrum of fundamental problems primarily associated with devising and discovering novel NEMS remains. These nanodevices can be classified as electronic and motion (rotational and translational transducers-actuators and sensors) nanoscale devices. This paper concentrates on the motion nanodevices. The key focus areas are synthesis, classification and analysis. We emphasize classification and synthesis paradigms with ultimate goal of classifying existing and discovering novel NEMS by performing electromagnetic-geometry synthesis. It is illustrated that NEMS intelligent databases can be developed within evolutionary-based CAD. The synthesis and classification paradigm reported directly leverages fundamental physics laws and high-fidelity modeling, allowing the designer to attain physical and behavioral (steady-state and transient) data-intensive analysis, heterogeneous simulation, optimization, performance assessment, outcome prediction, etc. We focus our attention on rotational and translational nanodevices which can be controlled by driving/sensing controlling/processing nanoelectronics. The examined nanodevices can be considered as NEMS as the electromagnetic-based nanomachines integrate motion and radiating energy nanodevices as well as nanostructures. [C3100]

"Subwavelength optical elements (SOEs) and nanofabrications-a path to integrate optical communication components on a chip"

Summary form only given. The paper presents a special class of optical devices, SOEs, which have feature size smaller than the wavelength of light and hence no non-zero order diffraction. SOEs drastically differ from bulk optics (i.e. ray optics) and diffractive optics in a number of ways. First, SOEs can perform conventional bulk optics functions, but with a size orders of magnitude smaller than bulk optics. Second, different SOEs can be made using the same materials but different nano-patterns, rather than different materials as in bulk optics. The two advantages make SOEs intrinsically suited for integration on a chip. Moreover, SOEs can offer new functionalities that bulk or diffractive optics do not have. SOE examples discussed include polarizers, beam splitters and combiners, waveplates, antireflection structures, filters (fixed or tunable), and lenses. Furthermore, integration of SOEs with lasers to control and tune laser properties (polarization, lasing mode and frequency, etc.) is explored. Finally, an innovative nanofabrication technology is described. [C3101]

"Nano-scale integrity and coherence of the S.I."

Traceable measurements at the nano-scale are usually made by establishing links to the scale of the S.I. base units all of which are defined at the macro-scale. We report the results of a study into the implications of the burgeoning developments in nano-technology on the realisation of S.I. quantities at the nano-scale. [C3102]

"Calculating magnetic susceptibility over multiple length scales"

DC power and radio frequency technology design can benefit from theories which predict magnetic permeability for a composite of nano-microscale magnetic particles in a magnetically neutral host. In this paper, composite permeability is calculated by connecting the microscale physics of the particles to the effective properties of the composite. At the microscale, numerical predictions are performed for a representative particle exposed to a magnetic field pulse. The simulation yields the particle's magnetic susceptibility, which is then generalized using magnetodynamics theory to obtain the susceptibility of a distribution of particles. The micro-magnetic study is extended to clusters of particles in order to study particle interactions. Effective medium theory is then used to describe the composite susceptibility of particles distributed in a neutral host. [C3103]

"Removal of oxygen atoms from a SiO₂ surface by incoherent vacuum ultraviolet excimer irradiation"

Summary form only given. Non-thermal photochemical removal of oxygen atoms from a SiO₂ layer on a silicon wafer using short wavelength emission has recently attracted much attention in the semiconductor industry and other related areas. It provides not only physics on the interaction between surface and high-energy photons, but also novel engineering aspects such as non-thermal nano-scale materials processing. In addition, the direct removal of oxygen atoms from a SiO₂ layer could open up the possibility of using a SiO₂ bulk as an insulator in the recent silicon-on-insulator (SOI) technology. The vacuum ultraviolet emission source was developed by use of a silent discharge, producing 9.8 eV photons with an intensity of 0.3 mW/cm². Such high photon energy is larger than the energy gap of the SiO₂. The high-energy photon, therefore, directly excites the electronic transition in SiO₂. The emission intensity is so low that a temperature rise of the SiO₂ surface was estimated of the order of 10-6K even during the irradiation. Surface morphology monitored by an atomic force microscope verified the non-thermal no damage processing. [C3104]

"Standing ultrasonic wave separator"

This paper presents the design and preliminary results for a flow-through particle separation unit using standing ultrasonic waves. The results indicate that good separation is obtained at residence times as low as 14 seconds and liquid velocities of 2 mm/sec. The effects of thermally and acoustically induced streaming are discussed. The unit is being used to assess the effective ranges and limits for key parameters in the design of larger scale units. [C3105]

"Self-propelled drop movement by manipulation of nanoscale adsorbates through molecular self-assembly"

We examined reactive wetting and transport phenomena of droplets on chemically patterned surfaces. We employed decahydronaphthalene (DHN) droplets that contained various amounts of an n-alkylamine to reactively wet and move about surfaces that expose a dense packing of carboxylic acid functionalities. The amine compounds adsorb onto this surface and produce one with a lower energy that exposes methyl groups, thereby causing a local surface energy gradient that is sufficient to induce a self-propelled movement of the contacting droplets on the surface. We employed patterning methods (micro-contact printing) to confine the direction of drop movement on these surfaces, thereby allowing direct measurement of fluidic movement and velocity. This ability allowed examination of the relationships between macroscopic droplet behavior and microscopic adsorption events. Specifically, we examined the effects of the force due to the unbalanced surface tension and of drop composition (adsorbate concentration) on the drop velocity, and analyzed these results using a thermodynamic approach. [C3106]

"Commercial evolution of nanotechnology"

Scientific & technological advancement is the primary factor to achieving sustainable economic growth. History has shown that breakthroughs in science that are rapidly commercialized shape the socio-economic landscape and are of immense importance to prosperity for businesses, governments, and industries. As the economy becomes even more global and competition increases, the ability to forecast the evolution of technology becomes more critical if businesses and countries are to remain competitive. Nanotechnology is a revolutionary science that will contribute to the economic prosperity of the businesses who commercialize the technology

early. This paper briefly reviews the commercialization of nanotechnology. [C3107]

"Quantum-coherent transport in coupled quantum-dots"

The details of electron interference in quantum-dot systems coupled via quantum point contacts (QPCs) is studied via simulation and experiment. In both open and closed coupled systems, one sees transitions from multi- to single-dot behavior, even when the QPCs support several modes. The results also reveal a non-trivial scaling of the conductance fluctuations in quantum-dot arrays, arising from the influence of the inter-dot coupling on energy hybridization. [C3108]

"Application-specific architecture for quantum cellular automata"

We show that a direct transposition of a generic IC architecture on a QCA technology is rendered inefficient by characteristics intrinsic to the model. This analysis constitutes the motivation for an application-specific architectural approach based on regular blocks proposed further in the paper. The basic architectural model is specified and a design methodology allowing the mapping of regular problems is described. [C3109]

"High yield non destructive purification of single wall carbon nanotubes monitored by EPR measurements"

A chemical purification method has been developed which leads to highly pure and little damaged single wall nanotubes (SWNT) with a 55 to 65% overall yield. It combines a short and soft acid reflux with a hydrogen peroxide reflux. Electron paramagnetic resonance (EPR) measurements have been used to assess the residual amount of both catalyst and amorphous carbon. By this method, the acid treatment duration was minimized to 4 h, preserving the SWNT structure. EPR indicates a decrease of amorphous carbon content by up to a factor 3 with a 90 minutes peroxide treatment. As-purified SWNTs allow us to generate nanoscale electronic devices via self-assembling. [C3110]

"Nanotechnology for smart flight control surfaces"

This paper focuses on the design of smart control surfaces for micro air vehicles using nano- and microscale actuators and sensors. These thin-film-based actuators/sensors are uniquely suitable for mini air vehicles, missiles, and interceptors. We use multi-layered microactuators (fabricated using thin-film technology) to displace and change the geometry of control surfaces. These thin-film actuators/sensors (transducers) are integrated as the large-scale arrays. Furthermore, nano- and microscale transducers should be controlled changing the applied voltage supplied to each actuator or measuring the voltage induced by each sensor. The major objective of this paper is to report fundamental and applied research in modeling, analysis and design of flight surfaces with thin-film-based actuator-sensor arrays controlled by hierarchically distributed systems. We demonstrate the feasibility and effectiveness of the application of smart flight surfaces for coordinated longitudinal and lateral vehicle control (pitch, roll, and yaw moments are developed deflecting and changing the geometry of control surfaces). Active aerodynamic flow control can be achieved in order to reduce the drag. [C3111]

"The effect of defects of single-walled carbon nanotubes on their hydrogen storage capacity"

Hydrogen absorption of single-walled carbon nanotubes synthesized by the HIPCO, laser ablation, and carbon-arc techniques are evaluated to determine the influence of their chemical and structural defect density on their effectiveness as the nanocontainers of hydrogen. The results indicate that although there was a difference in the defect concentration between the three different SWNT samples, these defects have little effect on their hydrogen storage capacity. [C3112]

"Millimeter wave SPDT switch for giga-scale system"

A driver-enhanced single pole double-throw (SPDT) switch was designed and implemented for giga-scale systems. The design was simulated on the Advanced Design System (ADS) package and implemented on RT-Duroid 5880 with 10 mils thick dielectric substrate in a 3-port WR28 waveguide, to validate the design for broadband application in Ka-band of digital millimeter waves. [C3113]

"Room temperature nanoimprint technology"

Nano-imprint-lithography (NIL) (Chou et al, 1997), in which resist patterns are fabricated by deforming the resist physical shape through embossing with a mold, is a very useful technique to make nanostructure devices and various nanostructure devices such as a quantized magnetic disk (Wu et al, 1998) have been demonstrated by this method. It has excellent features with sub-10 nm feature size over a large area with high throughput and

low cost. However, as a conventional NIL process has to heat a resist above the glass transition temperature to deform the resist physical shape with a mold pattern, the heating process causes serious problems for pattern accuracy. To overcome this problem, room-temperature replication into SOG (spin-on-glass) and HSQ (hydrogen silsesquioxane) (Namatsu et al, 1998) has been proposed and experiments have been conducted. In this paper, we describe a room-temperature replication into SOG/HSQ and a pattern transfer to a metal pattern and a substrate by using lift-off and RIE processes [C3114]

"Nano chamber fabrication on an acrylic plate by direct nano imprint lithography using quartz mold"

Nano-imprint lithography (S.Chou et al, J. Vac. Sci. Technol. vol. B14, p. 4129-4133, 1996) is a promising technology for nano structure fabrication with low cost. Several applications have been reported, whose targets are mainly fabrication of Si ULSI or other electric devices. In this work, we demonstrate nano holes fabrication on an acrylic plate using a quartz mold. The imprinted patterns could be applied to nano chambers for DNA analysis or anti-reflection structures for diffractive optical elements [C3115]

"Improvement of imprinted pattern uniformity using sapphire mold"

Imprint lithography is an attractive technology for LSI era below 40-nm critical dimension from the viewpoints of high-throughput and low-cost equipment. In order to avoid a pattern placement error due to thermal expansion in the conventional thermal imprint process, we have previously attempted to replicate a mold pattern onto a liquid polymer, which was solidified using ultra-violet (UV) light irradiation at room temperature. The imprint technology based on photo-induced solidification has several advantages such as elimination of heat-up and cool-down time and possibility of step and repeat process. However part of the solidified polymer film was remained on the quartz mold surface. In order to improve this problem, in this article we propose to use a sapphire plate as a mold [C3116]

"Direct patterning on low dielectric constant materials with electron beam lithography"

Summary form only given. Electron beam (EB) lithography and direct patterning of low-dielectric-constant (low-k) materials are two crucial issues of nanofabrication technologies. In this paper, we propose direct patterning of negative tone hydrogen silsesquioxane (HSQ) film of which can replace the use of resist processes including resist coating and stripping [C3117]

"Nano-topography removal employing numerically controlled local dry etching"

Summary form only given. With increasing packaging density and Si wafer size in the ULSI process, higher qualities are required for a Si wafer. Recently, an important quality indicator of the Si wafer was derived, that is the flatness with a spatial wavelength of several nanometer size which exists on a Si surface, called nano-topography. The reason is that CMP (chemical mechanical polishing) used for STI (shallow trench isolation) in the device process generates the nano-topography on the Si wafer surface, thereby degrading the uniformity of the Si oxide thickness. The Si wafer manufacturers have made efforts to establish a removal technology for the nano-topography in the fabrication process, however, no one has been successful in providing a technology by which the nano-topography once it is generated is removed positively. We have developed the NC-LDE technology (Numerically Controlled Local Dry Etching) by fusing the local dry etching technology with numerically control technologies to meet the requirement of Si wafer flatness, and NC-LDE is now utilized in production lines. Accordingly, this paper reports on the removal performance of the present nano-topography by employing the NC-LDE technology [C3118]

"Nanohole formation by FIB and its application to biomolecular sensors"

Rapid, reliable, and inexpensive characterisation of biomolecules, particularly nucleic acids and proteins, has become increasingly important. Among the current sensors, engineered transmembrane protein pores have been advantageous candidates for sensing elements. This sensor has two electrolyte-filled pools, which are separated by a lipid bilayer having a protein pore (e.g. α -hemolysin). The specimen molecules place in one of the pools can stochastically pass via the pore. They produce a fluctuating binary response in the transmembrane ionic current (Bezrukov et al, 1994; Li-Qun Gu et al, 1999). Instead of the protein pore, we have proposed use of nanometer-sized holes in a SiN xmembrane as a sensor head. We have fabricated the biomolecular sensor with nanoholes using a Si bulk micromachining technique (Fertig et al, 2000) and observed the ionic current via nanoholes. Through-nanoholes are formed by FIB (focused ion beam) (Yamaguchi et al, 1985; Gierak et al, 1997) [C3119]

"Nanotechnology toward DNA electronics"

Summary form only given. DNA is one of the most promising molecules which may act as the scaffold for molecular nanotechnology and nanoelectronics. DNA has the special double helix structure with π -electron cores of well-stacking bases for the use of long-distance (e.g. 200 E) and one-dimensional charge transport. The investigations of DNA in terms of the nanostructure, electrical conductivity and electronic states have significant implications for the application of DNA in electronic devices and in DNA-based electrochemical biosensors [C3120]

"Development of 3-D focused-ion-beam (FIB) etching methods for nano and micro-technology application"

Summary form only given. We have developed a 3-D FIB etching method for making 3-D micro-devices and sensors based on nano- and micro-technology. We fabricated single electron tunneling (SET) devices on a Bi-2201 single crystal whisker. We also describe 3-D FIB etching methods using layered single crystal whiskers as examples. These methods offer simple in situ etching and evaporation processes in FIB systems for making a micro area of stacks [C3121]

"Development of bio-MEMS devices for single cell expression analysis"

In order to provide total systems for single cell expression analysis, we have been developing a set of technology including cell cultivation, cell sorting, gene analysis from a specific cell, etc., using microfabrication technology. In this paper, we present the development of a cell sorter chip used as the core technology for establishing the cell sorting system that can separate and collect an individual cell according to its biological or biochemical information [C3122]

"A dynamic source-drain extension (DSDE) MOSFET using a separately biased conductive spacer"

We present a novel device to control short channel effects: a conductive spacer. Placed adjacent to (but isolated from) the gate stack, the conductive spacer functions as an auxiliary gate and is biased independently from the principal gate. This novel auxiliary gate is able to invert a portion of the channel adjacent to the LDD on both the source and the drain side, decreasing the effective channel length. Consequently, it is easier to turn the gate "off" and "on". Using T-CAD simulations, we show a four orders of magnitude reduction in I_{OFF} (at an I_{DSAT} of 700 $\mu\text{A}/\mu\text{m}$) using the conductive spacer device. Conductive spacers may be useful as scaling continues. It is predicted that nano-scale pass gates with I_{OFF} values as low as 1 pA/ μm may be attainable [C3123]

"Fabrication of GaAs-based integrated 2-bit half and full adders by novel hexagonal BDD quantum circuit approach"

Ultrahigh-density, ultrahigh-speed and ultralow power consumption logic circuits beyond the Si CMOS LSI scaling limit, realized by high density integration of nanometer-scale quantum devices, are promising candidates for use in advanced information technology. This will also find applications in the emerging wide range nanotechnology area, covering chemistry and biology, for nano-sensing, nano-scale signal processing and nano-control. However, no realistic approach for quantum integrated circuits has been established so far. To overcome this situation, we have recently proposed a hexagonal binary decision diagram (BDD) quantum circuit approach for high density integration of III-V quantum devices. The purpose of this paper is to investigate the feasibility of the novel hexagonal BDD quantum circuit approach through fabrication of GaAs-based BDD 2-bit half adder and full adder circuits [C3124]

"Characterization and modelling of nano-crystals for single electron memory point devices"

This paper presents some experimental results and a simple model for the study of capacitors containing silicon dots in silicon dioxide to be integrated in a new generation of nonvolatile single electron memories. This work is essential for the stabilisation of the technology to be used in the future for these devices aimed at very high memory arrays. [C3125]

"Effects of S/D non-overlap and high- κ dielectrics on nano CMOS design"

A new MOSFET structure with non-overlap S/D to gate and high- κ spacer was proposed. Extensive simulation data and some measured data were reported. The proposed structure showed very good subthreshold slope, DIBL, GIDL compared to those of overlap structure. By controlling the non-overlap length, we could obtain reasonable speed and on-current characteristics. Also we have shown the GIDL depends on strongly the difference of the gate and the spacer dielectric constants. Based on the results, we conclude reasonable non-overlap length is between 0 (just meet the gate edge) to 10 nm [C3126]

"Structure and resonant characteristics of amorphous carbon pillars grown by FIB-CVD"

Beam induced deposition is a superior technique for nano-fabrication and nano-mechanics that allows many degrees of freedom, so that any shape can be grown at any position with nanometer accuracy. We have already reported the three-dimensional growth of amorphous carbon, having a nanostructure of wineglass, coils, and bellows, using precursor of phenanthrene gas and a focused Ga⁺ ion beam (FIB) induced chemical vapor deposition (CVD). High-precision Ga-ion beams controlled by highly stabilized ion optics in an FIB system (SM15020, SEIKO Instruments) enabled not only normal growth of carbon nano-pillars on substrate, but also lateral growth. In this paper, we report an evaluation of the Young's modulus of such amorphous carbon pillars by measuring the resonant frequency of pillars. Many improvements are needed in our experimental conditions to clearly define the growth condition. However, the very large Young's modulus and the flexibility of the nano-structure fabrication in FIB-CVD holds great possibility for future applications of these DLC pillars grown by FIB-CVD [C3127]

"Thermal flow and chemical shrink techniques for sub-100 nm contact hole fabrication in electron beam lithography"

In the recent ITRS roadmap, electron beam based lithography would provide an approach to leading IC technologies from the generation of 180 nm. to sub-100 nm. As a consequence, high resolution and sensitivity resists for electron beam lithography are required. Suitable process enhanced techniques for improving resolution of resists is also essential. Chemically amplified resists have been widely used in deep UV optical lithography for high throughput considerations. Recently, resist thermal flow and chemical shrink techniques have achieved 100 nm patterns by utilizing conventional deep UV optical lithography. We characterized positive chemically amplified resists UV-86 (Shipley) and MES-1EG (JSR) for high-resolution electron beam lithography. We demonstrated thermal flow and chemical shrink techniques for sub-100 nm contact hole fabrication in electron beam lithography [C3128]

"Spacer FinFET: nano-scale CMOS technology for the terabit era"

A spacer lithography process technology using a sacrificial layer and a CVD (Chemical Vapor Deposition) spacer layer has been developed, and is demonstrated to achieve sub-40 nm structures with conventional dry etching. The minimum-sized features are defined not by photolithography but by the CVD film thickness. Therefore the spacer lithography technology yields CD (Critical Dimension) variations of minimum-sized features which are much smaller than achieved by optical or e-beam lithography. It also provides a doubling of device density for a given lithography pitch. This spacer lithography technology is used to pattern Si-fin structures for double-gate MOSFETs (FinFETs), and CMOS FinFET results are reported [C3129]

"Nano-processing using carbon nano tube probes and its device applications"

The new advanced technology which can grow the single wall carbon nanotube directly to the silicon tip is applied in the following three nano-electron devices. 1) The single wall carbon nanotube was used as a sharp AFM cantilever to improve the resolution of AFM image. The surface of gold(Au) and its cross section on the silicon substrate were observed using the carbon nanotube AFM cantilever and conventional AFM cantilever. 2) The single wall carbon nanotube with a diameter of 1~2nm was used as a sharp AFM cantilever and anodized the surface of the titanium (Ti) to form the narrow oxidized titanium (TiOx) tunnel junction of ~5nm for the room temperature planar type single electron transistor(SET). The fabricated SET shows the room temperature Coulomb diamond. 3) The single wall carbon nanotube was used as an ultra-sharp field emitter. The emitter has 10 to 20 times smaller diameter than the conventional silicon field emitter formed by the selective etching. The threshold voltage of the field emission for the carbon nanotube field emitter becomes as small as 10V which is 10~50 times smaller than the conventional silicon tip field emitter because of the smaller diameter of the carbon nanotube emitter [C3130]

"Structural analysis of a high-speed tool steel irradiated by an intense pulsed ion beam"

Summary form only given, as follows. Irradiation of an intense pulsed ion beam (IPIB) to a metal with a high power density and a short pulse duration leads to a rapid heating of the metal surface, which is followed by a rapid cooling with a cooling rate of 10⁷ to 10¹⁰ K/sec. The rapid heating and cooling produce nonequilibrium microstructures such as amorphous, nanocrystalline, or metastable phases in a metal surface layer, resulting in enhancement of mechanical and chemical properties. In this paper, the surface modification of a high-speed tool steel (SKH51) with irradiation of a proton-IPIB has been demonstrated experimentally. The non-irradiated sample consisted of an α -Fe structure and some second phase carbides such as VC, Cr₆C and Fe₆C. After I-pulse-irradiation, in the surface layer of the IPIB-irradiated sample, a high-temperature phase, γ -Fe, was formed

partially. The second phase carbides were dispersed from the irradiated surface, and the alloyed elements, V, Cr, and C were solved into the matrix of the γ -Fe structure. In addition, the average grain size was reduced from 8 μm to 240 nm by IPIB-irradiation. The γ -Fe was more dominant with an increase in number of IPIB-irradiation. After 10-pulses-irradiation, the single phase of the γ -Fe was formed in the surface layer of the sample, and the average grain size was estimated to be 40 nm. The γ -Fe structure, however, was converted into the α -Fe after 100-pulses-irradiation of the IPIB. The AES profile indicated that the alloyed elements were solved into the matrix of the α -Fe. This structure, martensite (α' -Fe), has excellent hardness and wear properties. The X-ray diffraction profile of the sample treated by 100-pulses-irradiation showed broadened diffraction peaks, indicating that the grain size of the sample was reduced to several nano-meters [C3131]

"Resonant tunneling of electrons in a crossed-field nanogap"

Summary form only given. In the emerging fields of nano-technology, electrode gaps with scales down to nanometer regime can be easily be fabricated. On such a nanoscopic scale., quantum effects such as electron tunneling will become important in the beam-gap interaction when the gap spacing is smaller than the electron wavelength. In this paper, we study the resonant tunneling of electrons in a crossed-field nanogap. By ignoring the space-charge effects, the combination of the magnetic field and the DC electrostatic field will produce a barrier-well-barrier like potential field. By solving the 1D time-independent Schrodinger equation, we find that the energy levels of the electrons are quantized, and resonant tunneling occurs when the emission energy of the electrons equals to the discrete energy levels. The transmission coefficient (T) of the electron is formulated as a function of normalized parameters, which depends on the gap spacing, DC gap voltage, magnetic field, emission energy, and surface potential energy of the cathode. Our results show that there is an optimum magnetic field for perfect electron transmission ($T=1$) from the cathode to the anode. The application of this work will be discussed [C3132]

"Nano-focusing of light"

Summary form only given. Most metals have negative dielectric functions and their surfaces support plasma modes that couple to incident light. Focusing of surface plasma modes is not restricted by the free space wavelength offering the possibility of huge concentrations of radiative energy in very small volumes. In a recent refinement we showed that at the frequency where $\epsilon = -1$ a highly conducting metal such as silver can act as a lens, refocusing electrostatic fields defined in some object plane, into an image plane some distance away. [C3133]

"Nano- and picosecond pulsers on the basis of FED and DRD"

Summary form only given, as follows. FID technology has developed a new class of superpower closing switches with picosecond operation (FID) and opening switches (DRD) with nanosecond operation. Each of those devices allows switching voltage of tens and hundreds kilovolts with currents higher than 10kA. FID and DRD allowed to develop a series of pulsers with pulse width from 100ps to several hundreds nanoseconds. The pulse shape can be bell-shaped (Gaussian), square or bipolar. Pulse repetition frequency depends on the average power and is usually several kilohertz. There are modifications of the nanosecond pulsers with peak power 20-30MW and dimensions 150x120x60mm. The example are the pulsers FPG-HV and FPG-S-HF: maximum amplitude 1-10kV, pulse duration 0.1-1ns, rise time 100ps, PRF 100-500kHz [C3134]

"Mechanism of nonlinearity in semiconductor doped glasses using Z-scan method"

Summary form only given. The third-order nonlinearity in the transparency region ($2\hbar\omega < E_g < \hbar\omega$) of semiconductor doped glasses (SDGs) containing CdSxSe_{1-x} -nano-particles has been studied over the last few years. There is a discrepancy over the magnitude and mechanism of nonlinearity in SDGs both in Z-scan and degenerate four wave mixing (DFWM) experiments. The discrepancy has been resolved in DFWM experiments, with nonlinear refraction due to carriers generated by two-photon absorption (TPA) being the dominant mechanism. This is a fifth-order effect. The intrinsic third-order electronic nonlinearity in these samples is positive as measured by nondegenerate four wave mixing experiments and is much smaller in magnitude compared to the fifth-order nonlinearity. Picosecond pulses have mainly been used for the Z-scan experiments. For Z-scan, the theoretically simulated data in SDGs with picosecond pulses indicates that it is difficult to distinguish between third and fifth-order nonlinearity. In this paper, we show that by performing the Z-scan with picosecond and femtosecond pulses, one can distinguish between the third and fifth-order processes. We observe the signature of positive third-order nonlinearity in the Z-scan experiments with femtosecond pulses [C3135]

"3rd International Conference 'Novel Applications of Wide Bandgap Layers' Abstract Book (Cat.

No.01EX500)"

The following topics are dealt with: activated CVD; ion beam nucleation; wide bandgap II-VI compound thin films; advanced microelectronic technology; optoelectronic devices; UV-extended spectroscopic ellipsometry; medical applications; electrochemistry; reactive magnetron sputtering; X-ray diffraction of epitaxial lateral overgrowth layers; nano-diamond films; composite layers; plasma jet deposition; PECVD; chemical bath deposition; grain boundary transport properties; amorphous superlattice structures; FTIR spectroscopy; annealing; unipolar heterostructures; fretting; optical parameters; tribological properties; etching; plasma processing; MOSFET gate stacks; shape memory alloys; thermal oxidation; heart valves; DNA sequencing chips; radiotherapy dosimetry; solar cells; quantum well separate confinement heterostructure lasers; Schottky barriers; field emission arrays; sensor applications; optical fibres; Schottky diodes; field effect transistors; organic electroluminescent devices [C3136]

"Microelectronics/nanoelectronics and the 21st century"

The advent of nonphotolithographic lithography, new electronic materials, and the devices, circuits, and systems they enable will see the electronics revolution of the 20th century to continue well into the 21st century. New lithographic techniques using tools such as nano-imprint and AFM are expected to lead to electronic circuits with lateral spatial resolution under 10 nm. When coupled with innovative materials such as those exhibiting giant magnetoresistance, new ultradense, ultrafast, nonvolatile memory is expected to ensue. New records are expected to be set in solid state laser output power when new wide bandgap semiconductors are combined with concepts such as the quantum cascade laser. Differential etching techniques that have proven efficacious in the design of surface emitting lasers are expected to propel bipolar transistor switching speeds into the THz spectrum with resultant logic devices clocking at well over 100 GHz. This increase will lead to improved signal processing capability. New advances in control of the phase stability of local oscillators and amplifiers will lead to electromagnetic systems with much greater Doppler resolution for radar and much better spectral utilization for communications systems. Devices and ICs combining semiconductors and magnetic spin states are expected to lead to a new class of ICs whose functionality can be dynamically changed in order to adapt optimally to the computational or sensing requirements of the moment. Further advances are expected to accrue in the area of nanophotonics, where device sizes can be smaller than the wavelength of the light they emit or receive [C3137]

"Fabrication of nanostructures with interferometric lithography"

Summary form only given. Nanostructures, features with characteristic dimensions between 1- and 100-nm, are the focus of much current attention as a result of the unique physical properties offered in this mesoscopic regime. As semiconductor-processing technology has matured, the ability to create small structures has improved. Traditional nanostructure fabrication involves serial processing, e.g. e-beam lithography. For many applications, such as heterostructure crystal growth, a large-area parallel processing capability is vital. One optical lithography technique, interferometric lithography (IL), is a powerful technique for making nanostructures, providing an inexpensive method to generate nano-scale features over large areas [C3138]

"Digital to analog conversion performed in single electron technology"

Investigates SET devices from the logic design perspective, using the SET tunnel junction's ability to control the transport of individual electrons. We introduce a modified turnstile circuit with clock and enable control signals, which has built-in memory and reset functionality. Using the modified turnstile circuit as a building block, we propose a scheme for an n-input digital to analog converter. We demonstrate the scheme by implementing and simulating a 3-bit digital to analog converter [C3139]

"Survey of nanomanipulation systems"

Nanomanipulation as a new emerging area enables to change, interact and control the nano scale phenomenon precisely. Nanomanipulation systems are surveyed in this paper. Nanomanipulation approaches are grouped according to their starting point, utilized process, operation type, manipulation environment, interaction type, etc. Main components of such systems such as nanomanipulators, nano physics, sensors, actuators, and control are given in detail. Problems are defined and possible solutions are proposed. Moreover, possible applications in biotechnology, computer technology, material science and micro/nanotechnology are reported [C3140]

"Artificial cellular device with cell-free protein synthesis ability constructed by chemical IC chips"

The world's first "in-chip cell-free protein synthesis from DNA" in biochemical IC chips was demonstrated. A luminous protein of the firefly "Luciferase" was synthesized from DNA and monitored in real time. Compared with conventional protein synthesis process with a living cell, this in-chip method provides low-cost, high-throughput

protein production. This micro chemical laboratory was constructed by prefabricated biochemical IC chips proposed and developed by the authors. Each chip was three dimensionally fabricated by using "hybrid micro stereolithography". In addition, advanced biochemical IC chips made it possible to improve both the productivity and the reliability of protein production. The results provide the powerful new method demanded by post-genome research to find the relationship between gene and protein. User assembled versatile biochemical IC chips provide reduced experimental throughput time and lower the cost of expensive biochemical reagent and apparatus for various kinds of protein synthesis. DNA originated cell-free protein synthesis is one of the biggest key technologies not only for life science but also medicine and drug discovery [C3141]

"Towards nanotechnology computer aided design: the NANOTCAD project"

We discuss the motivation for the detailed simulation of nanotechnology devices and the challenges that it poses. Then, we present the approach to the numerical simulation of semiconductor nanostructures adopted within the project NANOTCAD, funded by the European Union within the Fifth Framework Programme, in the Future Emerging Technologies Initiative of the Information Society Technology Program. Results obtained from the initial development of a three-dimensional Poisson-Schrodinger solver are also shown [C3142]

"Near-field photolithography by a fiber probe"

Since Near-field Scanning Optical Microscopy (NSOM) was developed in 1992, many researches have been proposed to prove that it could be used in nano-fabrication because near-field optical technology can overcome the optical diffraction limit. By using near-field photolithography, we made a narrow groove (128 nm, FWHM) by an optical fiber probe with Ar⁺ laser (488 nm). This result shows the near-field lithography's superiority because the linewidth is smaller than one-third wavelength (162.7 nm), and the minimal linewidth of classic optical lithography should be larger than half wavelength (244 nm) [C3143]

"Nano-scale defect investigation by site-specific transmission electron microscopy and electron energy loss spectroscopy"

For the yield enhancement of sub-micron devices, physical or chemical analysis of very small feature is strongly needed. Transmission Electron Microscopy is well capable of such tasks. This paper gives a few case studies, in which cross-sectional TEM is effectively used for failure analysis. Each of them deals with sub-micron defect, which was isolated by functional and/or electrical tests. The defects were prepared for TEM investigation by using Focused Ion Beam technique with sub-micron special accuracy. Case studies describe an inter-metal contact open, metal to metal short, and diffusion to substrate short, where unique mechanism of dislocation generation in silicon were observed. Practical applications of Electron Energy Loss Spectroscopy (EELS) are also described [C3144]

"Nanostructures of zero magnetization in orthoferrites"

In orthoferrites-canted ferromagnets with extremely high domain wall velocities-the change of handedness in the domain walls does not occur in Bloch lines but in lines of zero magnetization, which represent magneto-optical nanostructures. Observations of the lines and of the domain wall inclinations in plates of yttrium orthoferrite are reported. The inclinations take place in the direction of the crystallographic α axis and reach tens of degrees [C3145]

"Fabrication of magnetic nanostructures using the focused ion beam technique"

A potential approach to extend the current areal density of magnetic recording beyond 300 Gb/in² is physical patterning of the media. Among all the techniques that have been employed to-pattern the continuous media into nanometer scale discrete tracks and bits, the focused ion beam (FIB) nanofabrication is one of the most straightforward techniques that does not require the use of various types of masks and molds. There has been much interest in nano-patterning of hard and soft magnetic materials and perpendicular recording media using the FIB, but very few of them has been focused on the milling processes. In this work, the FIB patterning of commercial post-sputtering longitudinal media is demonstrated. Special efforts have been put on optimizing the milling process through controlling the magnification, milling depth, and the ion beam scan mode. It was found that the parallel milling mode was effective in reducing the re-deposition at small depth and thus led to smaller nano-structures. The FIB processed nanostructures have been characterized using AFM and MFM. Patterns with square islands of 50 nm and spacing of 10 nm have been obtained. It is interesting to note that, in both serial and parallel milling modes at large depth, the re-deposition has accumulated at the junctions of the original dots and formed new dots. As dots formed by re-deposition have already lost their magnetic properties, they should be suppressed as much as possible. In the contrast to this, the re-deposition was almost eliminated in the parallel-milling mode at small depth. It can be seen clearly from the MFM observation that the in-plane

magnetization has been pertained for the patterned structures at dimensions as small as 50 nm and single domain structures were observed. The structures obtained in this work can be used to study magnetic recording at contact mode and at very high recording density [C3146]

"Double-gate fully-depleted SOI transistors for low-power high-performance nano-scale circuit design"

Double-gate fully-depleted (DGFD) SOI circuits are regarded as the next generation VLSI circuits. This paper investigates the impact of scaling on the demand and challenges of DGFD SOI circuit design for low power and high performance. We study how the added back-gate capacitance affects the circuit power and performance; how to trade off the enhanced short-channel effect immunity with the added back-channel leakage; and how the coupling between the front- and back-gates affects circuit reliability. Our analyses over different technology generations using MEDICI device simulator show that DGFD SOI circuits have significant advantages in driving high output load. DGFD SOI circuits also show excellent ability in controlling leakage current. However, for low output load, no gain is obtained for DGFD SOI circuits. Also, it is necessary to optimize the back-gate oxide thickness for best leakage control. Moreover, threshold variation may cause reliability problem for thin back-gate oxide DGFD SOI circuits operated at low power supply voltage [C3147]

"Fluidics-the link between micro and nano sciences and technologies"

Microfluidics is a collection of processes for moving bulk fluid mass or controlling the paths of selected embedded particles, cells or molecules, in flows. Length scale matching between the flow and the device is the key for efficient momentum and energy transfers of the desired fluid motions. MEMS enable us to handle minute amounts of fluid in the nano or pico liter range. With properly designed microfluidic devices, molecules can be directly manipulated by the flow patterns inside the device, which provides a pathway to exploit the nano world. Obviously, understanding of the molecular effects on flows becomes a crucial issue. In traditional fluid dynamics, the flow length scale is much larger than the molecular length scale. Continuum is the most common hypothesis for flow researches. In the case of micro/nano engineering system, we are in the transition regime between continuum and molecule dominated conditions. This feature brings us the challenges when exploring the science and developing the technology in micro/nano fluidics [C3148]

"High throughput optical near-field aperture array for data storage"

To create and utilize a strong light source with sub-wavelength size has opened up a new field, the near-field optics. One of the most attractive applications of the near-field optics is the next generation optical data storage. The optical memory with high density and high data transfer rate is highly demanded to utilize an array of high throughput nano-scaled light sources for writing and reading bits on a medium. In this paper, we propose a hybrid laser and aperture array for optical near-field memory head, namely VCSEL/NSOM. A systematic investigation of the optical performance of the near-field light at the apertures of the Si micromachined tip array is presented. A primarily result of writing and reading bits on a phase change medium using the fabricated structure is demonstrated [C3149]

"Processing of polymer-ceramic nanocomposites for system-on-package applications"

This work focuses on studying and optimizing the dispersion of nano-sized ceramic particles in PGMEA, which is the solvent for the selected host polymer. High solids loading leads to entrapment of porosity in the microstructure, which lowers the effective dielectric constant of the films. The amount of solvent in the suspension and the spin coating speed were found to impact the dielectric constant of high filler content nanocomposites. The interplay between the rheological properties of the suspension and processing parameters such as solvent content and coating speed and its impact on the dielectric properties of the film is discussed. Porosity of thin film composites was measured for the first time to study the impact of these processing parameters. Powders of different particle sizes were mixed to obtain bimodal particle size distribution to increase the packing density of the composite. Packing density was improved by modifying the dispersion methodology and a nanocomposite of dielectric constant as high as 135 was obtained [C3150]

"Material characterization of high dielectric constant polymer-ceramic composite for embedded capacitor to RF application"

Embedded capacitor technology can improve electrical performance and reduce assembly cost compared with traditional discrete capacitor technology. Polymer-ceramic composites have been of great interest as embedded capacitor material because they combine the processability of polymers with the desired electrical properties of ceramics. A novel nano-structure polymer-ceramic composite with very high dielectric constant ($\epsilon_r \sim 150$, a new

record for the highest reported ϵ value for a nano-composite) has been developed in previous work. RF application of embedded capacitors requires that the insulating material have high dielectric constant at high frequency (GHz), low leakage current, high breakdown voltage and high reliability. A set of electrical tests have been conducted in this work to characterize the properties of the in-house developed novel high dielectric constant polymer-ceramic nano-composite. Results show that this material has a fairly high dielectric constant in the RF range, low electrical leakage and high breakdown voltage. An 85/85 TH aging test has been performed and has shown that this novel high-k material has good reliability. An embedded capacitor prototype with capacitance density of 35 nF/cm has been manufactured using this nano-composite with spin coating technology. This novel nano-composite can be used for integral capacitors in RF applications [C3151]

"Repeater insertion to minimise delay in coupled interconnects"

Signalling over long interconnect is a dominant issue in electronic chip design in current technologies, with the device sizes getting smaller and smaller and the circuits becoming ever larger. Repeater insertion is a well established technique to minimise the propagation delay over long resistive interconnect. In deep sub-micron technologies, as the wires are spaced closer and closer together and signal rise and fall times go into the sub-nano second region, the coupling between interconnects assumes great significance. The resulting crosstalk has implications on the data throughput and on signal integrity. Depending on the data correlation on the coupled lines, the delay can either decrease or increase. In this paper we attempt to quantify the effect of worst-case capacitive crosstalk in parallel buses and look at how it affects repeater insertion in particular. We develop analytic expressions for the delay, buffer size and number that are suitable in a-priori timing analyses and signal integrity estimations. All equations are checked against a dynamic circuit simulator (SPECTRE) [C3152]

"Small size solid state nano- and picosecond pulsers on the basis of fast ionization devices"

FID Technology has developed a new class of superpower closing switches with picosecond operation (FID) and opening switches (DRD) with nanosecond operation. Each of those devices allows switching voltage of tens and hundreds kilovolts with currents higher than 10 kA. On the basis of the FID and DRD there has been developed a new class of the nano- and picosecond pulsers. [C3153]

"Micromachined tools for nano technology. Twin nano-probes and nano-scale gap control by integrated microactuators"

This paper describes the fabrication and actuation of a novel device composed of twin nano probes. The size of the probes are 200 nm-high, 280 nm-wide and 5 μ m-long, which are formed by silicon anisotropic etching. The initial gap of about 400 nm between the probes become 84 nm when 101 mW input power was given to the thermal expansion micro actuators integrated with the probes. Precise motion down to 4 nm/mW was confirmed by simultaneous TEM observation [C3154]

"Ultra-precision micro structuring by means of mechanical machining"

A variety of microstructures with high accuracy were introduced by means of mechanical machining technology, using the authors' super-nano friction free machine [C3155]

"A mixed mode self-programming neural system-on-chip for real-time applications"

The paper provides an overview of the development of a self-learning computing chip in the new 0.18 micron copper technology. The chip realizes an architecture that achieves the task of self-learning execution times in microseconds to milliseconds. The core consists of basic building blocks of 4-quadrant multipliers, transconductance amplifiers, and active load resistances, for analog (forward-) network processing and learning modules. Superimposed on the processing network are digital memory and control modules composed of D-flip-flops, ADC, multiplying D/A converter, and comparators for parameter (weight) storage, logical control and analog/digital conversions. The single system-on-chip design impacts several domains of critical applications that include nano-scale bio-technology, automotive sensing, central and actuation, wireless communications, image feature extraction and pattern matching, etc [C3156]

"Internet-based remote sensing and manipulation in micro environment"

Recent developments in the Internet have significantly increased the human capability to reach and obtain information from remote locations. In parallel, the advent of micro sensors and actuators makes it possible for humans to sense and act in a microenvironment. Combined, the Internet and MEMS will produce a new technology for humans to sense and act in remote microenvironments, allowing the potential development of micro teleoperation and micro automation technologies. These new technologies have potential impact on

several fields, including remote micro automation and biomedical engineering. In this paper, we will present our ongoing development of polyvinylidene fluoride (PVDF) sensors that can be used for force-reflective control of micromechanical devices over the Internet. Internet based teleoperation between Hong Kong and Michigan State was demonstrated using an event-based control scheme, which ensured stability and synchronization. Control was enhanced by multimedia feedback, which included, in addition to the traditional video, force feedback. The force fed back augmented the limited information supplied by visual feedback. We believe this project will eventually make a great impact to the globalization of MEMS foundries because it will allow global users to micro-assemble and micro-manipulate surface micromachined devices from their laboratories, and hence, reduce the time from design to production significantly [C3157]

"Study of nanocrystalline zinc oxide phosphor for field emission display"

Nanocrystalline ZnO phosphor powder has been prepared using hydrothermal method. Its structure and morphology are studied. The cathodoluminescent characteristic of the nano-ZnO phosphor is studied in a field emission device [C3158]

"Emission site control in carbon nanotube field emitters by focused ion beam irradiation"

Effect of ion irradiation on emission behavior in CNT (carbon nano tube) emitters has been investigated using focused ion beams (FIBs). The improvement in emission behavior with a drastic reduction in turn-on voltage and increase in emission current was found after FIB irradiation in CNT emitters [C3159]

"Speed-power-accuracy trade-off in high-speed ADCs: what about nano-electronics?"

In this article the fundamental trade-off between speed, power and accuracy for high-speed converters is reviewed with respect to technology scaling. The never-ending story of technology trends towards smaller transistor dimensions has resulted to date in deep sub-micron transistors with lower supply voltages. It will be shown that in future technologies the power consumption of high-speed ADCs will increase to achieve the same accuracy and speed [C3160]

"High K polymer-ceramic nano-composite development, characterization, and modeling for embedded capacitor RF application"

Embedded capacitor technology can improve electrical performance and reduce assembly cost compared with traditional discrete capacitor technology. Polymer-ceramic composites have been of great interest as embedded capacitor material because they combine the processability of polymers with the desired electrical properties of ceramics. A novel nano-structure polymer-ceramic composite with very high dielectric constant ($\epsilon_r=150$) has been developed in this work. RF application of embedded capacitors requires that insulating material have high dielectric constant in higher frequency (GHz), low leakage current, high breakdown voltage and high reliability. A set of electric tests have been conducted in this work to characterize the properties of the in house developed novel high dielectric constant polymer-ceramic nano-composite. Results show that this material has fair high dielectric constant in RF range, low electric leakage and high breakdown voltage. An embedded capacitor prototype with capacitance density of 35 nF/cm² has been manufactured using this nano-composite and spinning coating technology. The design of embedded passives is very important to its practical application. The commercial finite element software ANSYS and electric simulation software SPICE were used for the simulation of embedded capacitor performance in the RF range. This novel nano-composite can be used for the integral capacitors in the RF applications [C3161]

"New insights into breakdown modes and their evolution in ultra-thin gate oxide"

By carefully analyzing post-breakdown current-voltage characteristics of MOS devices, it was found that the soft-breakdown mode typically induced in devices with oxide thinner than 3 nm is quite different from that with oxide thicker than 3 nm. Based on our findings, a unified model is proposed to explain the evolution of different breakdown modes. Impacts of each breakdown on the device's switching behavior are also discussed [C3162]

"NASA Sun-Earth connection program strategic mission and technology requirements (2006-2015)"

Our variable star, the Sun, is the source of varying solar wind, electromagnetic radiation and electromagnetic particles that interact with the Planets and the Galaxy. The Sun-Earth Connection (SEC) Theme in the NASA Office of Space Science (OSS) has a strategic goal to understand our changing Sun and its effects on the Solar System, Life and Society. This paper describes the planned SEC strategic missions planned for the period 2006-2015 and their technology requirements. These missions range from individual spacecraft to clusters and constellations of micro-nano satellite missions utilizing both imaging and in-situ instrumentation. Enabling

technologies include micro-nano satellite and instrumentation along with solar sail propulsion providing reduced flight times and unique nonkeplerian orbits to extend traditional vantage points. Enhancing technology requirements related to instruments and subsystems are described that will improve payload mass-fraction, improved performance and lower cost [C3163]

"Man-machine interface for micro/nano manipulation with an AFM probe"

In this paper, elements of a human-machine interface for teleoperated nano scale object manipulation are discussed. Atomic Force Microscope (AFM) probe based sensing and manipulation is connected with direct teleoperation technology for putting human operators inside the nano world for interacting with surfaces and manipulating objects at the nanoscale. 3 d.o.f. PHANTOM haptic device is utilized as the master manipulator, and piezoresistive MEMS fabricated AFM probe is selected as the slave manipulator. A computer graphics display is designed to provide the sense of real-time vision to the operator where the objective scale is beyond real-time vision limits. This is achieved by modeling the surface deformation and the cantilever deflection and providing the human operator with a 3D display of the task environment. Simulations and experiments are made to show the performance of the interface system [C3164]

"Multiscale approaches to thermoelectric materials and devices"

Performance of thermoelectric materials and devices depends upon various features on different levels from microscopic to macroscopic scales. On the atomic scale, to find new multi-component compounds with complex electronic and crystal structures is a way to high-Z thermoelectric materials. On the nano-scale, quantum wells, wires and dots are considered to be the dawn for breaking the traditional barrier of $ZT \sim 1$ existing for several decades. From the point of view of microstructure, inhomogeneities in thermoelectric materials, such as interfaces/grain-boundaries and inclusions, have significant influences on their thermoelectric properties. On the macroscopic scale, the thermoelectric device functions depend on thermoelectric materials used for building the device and device configuration (such as multistage or segmented devices). This review briefly presents the state-of-the-art and perspectives in the multiscale understanding of thermoelectric materials and devices [C3165]

"A study of TiO₂, BaO and SrO thin films deposited by electrostatic spray assisted MOCVD"

In this study, the electrostatic spray assisted ESA-MOCVD is found to have the advantages of simple apparatus without gas lines, easy control of nano-sized droplets by applied voltage and solution rates, and easy control of thin film compositions by controlling the starting solution composition. The effect of deposition parameters on the growth behavior of TiO₂ thin films such as substrate temperature, deposition time, applied voltage, oxygen rates, and annealing effect were investigated. The microstructure, composition and roughness were characterized by SEM, XPS and AFM, respectively. XRD was used to determine crystallization. Finally, we found how to adjust to deposit BaO and SrO thin films by ESA-MOCVD [C3166]

"The p-channel Si nano-crystal memory"

The feasibility of p-channel nano-crystal memory is demonstrated. The programming mechanism of p-channel nano-crystal memory was investigated by charge separation measurement. For small programming voltage, hole tunneling is dominant. However, valence band electron tunneling becomes dominant for large voltage [C3167]

"Fabrication of thermoelectric materials with bismuth nanowire array"

It has been theoretically verified that the thermoelectric performance can be improved greatly when normal thermoelectric materials possess low dimensional structure. In our lab., Doped N-type and P-type Bi nanowire array thermoelectric materials have been fabricated by electrodeposition technology. The porous alumina films with nano-pore array structure were used as template, and one-dimensional thermoelectric materials dispersed in alumina matrix have been obtained, and their composition and structure have been analyzed [C3168]

"Technical Digest. CLEO/Pacific Rim 2001. 4th Pacific Rim Conference on Lasers and Electro-Optics (Cat. No.01TH8557)"

The following topics are dealt with: microstructured fibers and devices; photonic crystals; thin film and nanoparticle formation; functional structure fabrication; x-ray lasers; laser based high energy physics; high intensity laser technology; LiNbO₃ waveguide devices; QPM devices and applications; advanced photonic sensing; atmospheric Lidars; Lidar technologies; nanostructures and nanosystems; imaging spectroscopy of semiconductor nanostructures; ceramics lasers; new scheme lasers; techniques for biomedical optics; second-generation photomedicine; dynamics in semiconductor optical amplifiers and lasers; wavelength control for WDM applications; laser processing; micro and macro engineering; strong-field interaction and applications; optical

coherence tomography; spectroscopy and imaging for brain and tissue characterization; integration and packaging; photonic network devices; DWDM components; optical MEMS; THz-radiation and nonlinear devices; nonlinear optics in fiber; nonlinear optical devices in optical communication; lasers and electro optics; photonic sensing; sensing devices; distributed photonic sensing and photonic sensing networks for reliability, safety and security; spectroscopy in nano-photonics; atom manipulation and nano-fabrication; semiconductor materials; Yb and Nd:YAG lasers; new sources; advanced industrial lasers in 21st century; eyesafe laser radar; physics of ultrafast phenomena; ultrafast pulse technologies and their applications; high density optical disk; devices for transmission systems; short wavelength and widegap material lasers; semiconductor lasers for lightwave communications; light sources for DWDM applications; materials for nonlinear optics; optical chaos; nonlinear optical devices in UV; quantum information; optical state control and detection; lasers and spectroscopy; UV nonlinear optical materials; photorefractive materials; bulk and thin film materials; new lasers; analog signal processing; short pulse generation and control; ultra high density optical disks; transmission technologies; optical networking; IP over DWDM networks; access networks for Internet era; VCSELs for datacom; long-wavelength VCSELs and related materials; VCSELs and microcavity lasers; nonlinear coherent systems; atom optics and laser cooling; ultrafast phenomena-molecules; ultrafast phenomena-coherence control; image processing; novel materials; organic optical materials; photonic information processing systems; holographic devices and systems; spatiotemporal information processing; ultrafast optical devices; ultrafast pulse characterization; THz generation and photoconductive switches [C3169]

"Static and dynamic characterization of MOS capacitors containing nano-crystal silicon dots"

We present some experimental results and a simple model for the study of capacitors containing silicon dots in silicon dioxide to be integrated in a new generation of non volatile single electron memories. This work is essential to stabilise the technology to be used in the future for these devices in very high density memory arrays [C3170]

"Development of a force-reflection controlled micro underwater actuator"

The ability to manipulate and control biological cells with reflective-force information is a key technology necessary for many new applications in bio-MEMS, but is currently lacking in all cellular manipulators. We report our preliminary experimental work in using an ionic conducting polymer film (ICPF) to develop a biological cellular robotic gripper with force sensing capability. ICPF actuators are able to give large deflection with small input voltage (~5V) in aqueous environments, and also able to give relatively large output voltage due to deflection by mechanical forces. Thus, ICPF actuators are investigated as possible cellular force-reflection controlled manipulators in our work. Individual multi-finger grippers with dimensions of 200µm Ч 200µm Ч 3000µm for each finger were realized. We report on the design, fabrication procedures, and operating performance of our ICPF actuators. Further development in the reduction of size of these actuators will enable effective force-feedback control of underwater micro objects and lead to new frontiers in cellular manipulation [C3171]

"Mass SURFER: a low-power underwater mass spectrometer for monitoring dissolved gas, solutes and large organic compounds"

The authors are currently developing two low-power, miniature mass spectrometer-based field-sampling systems-a "standard" and CE (capillary electrophoresis)-enhanced version-with an aquatic-based sensor head, vacuum system, pressure case and associated electronics, called Mass SURFER (Mass Spectrometer Using Rotating fields for Exploratory Research). The units incorporate the Rotating Field Mass Spectrometer (RIMS) developed at JPL, and are capable of 2000+ m deployments. Seawater-soluble gas samples are either admitted through an osmotic membrane boundary into a gas-based field ionizer, or the seawater liquid with its load of dissolved gases can be directly injected into a submersible vacuum chamber via a nano-electrospray nozzle (liquid/vacuum interface). The gas-sampler (first type) incorporates a hydrophobic, silicon-coated membrane. The membrane allows dissolved gases to enter the vacuum interface where small aliquots are sampled. The second interface is an on-line capillary nano-electro spray interface (ESI) capable of high-sensitivity mass spectrometry at nanoliter per minute flow rates. Mass SURFER vacuum levels need only be at the milli-torr level for a quality measurement, and the complete system nominally draws <10 watts when active [C3172]

"Operation of a 3D nano-electron cell for logic and memory"

In this paper, by exploring the negative differential conductance (NDC) of a resonant interband tunneling diode (RITD), e.g. InAs/AsSb/GaSb, and the interaction between metallic nano-dots, we present and demonstrate a theoretical model of a novel bi-stable and 4-stable operation on the basis of the three-dimensional (3D) nano-electron cell which consists of metallic nano-dots forming into compact and two-dimension (2D) arrays on the

surface of RITDs. We present a simplified circuit model without considering single-electron effects between metallic nano-dots, where the RITD is described by a simplified physics-based model. We investigate numerical results for this 3D nano-electron cell and their dependence on the relevant parameters. At last calculations based on Monte Carlo simulation considering single-electron effects between metallic nano-dots demonstrate that our simplified model is comprehensive enough to describe this system in nature. The calculated results demonstrate it is promising for future nano-logic and nano-memory applications. [C3173]

"MIS-nano-structure creation by the ion bombardment of HTSC-surfaces"

A new way of controlled fabrication of "metal/insulator/superconductor" (MIS) structures with nano- and subnanometer thickness of layers and interfaces is suggested. The way is based on the effect of ion-induced self-organizing restructuring of the near surface region of high temperature superconductors (HTSC). The chemical bond breaking of metal atoms with oxygen stimulated by the bombarding ions is the first stage of the effect. Then the metal atoms diffuse to the surface and form a metallic segregate in the form of a film or a cluster ensemble depending on the ion energy and irradiation dose. The irradiated region loses its superconductivity and is transformed into insulator. The thickness of the dielectric layer is determined by the penetration depth of ions which can be regulated by variation of their energy. The processes pointed out and the properties of the created structures have been studied using electron spectroscopy. As compared to the known structures, the discovered ones are characterized by qualitatively thinner layers and interfaces. [C3174]

"Network device technologies for ubiquitous IT in the 21st century"

Summary form only given. We discuss progress and prospects of network device technologies for ubiquitous communication systems in the 21st century. Broadband and mobile/wireless networks will remove various bottlenecks which block the way to the ubiquitous information society. After a brief overview of the direction toward ubiquitous information technologies, we discuss the technology roadmap with emphasis on broadband photonic network systems as well as access networks. The discussion shows that nano-scale network device technologies will play a key role in the realization of high-performance or low-cost network devices. Nano-scale network devices are based upon various innovative technologies including quantum dots, photonic crystals, and nano-scale controlled interfaces of various emerging materials such as III-nitrides and organic semiconductors [C3175]

"Single electron memory effect in TiOx nano-structure"

The single electron memory effect in TiOx nanostructure (thickness 3nm, length 150 nm and width 150 nm) based on localized density of state (LDOS) in metallic oxides is observed. The potential of application in the single electron memory is discussed. [C3176]

"Ta-rich tantalum silicide nano-cluster diffusion barrier in ULSI metallization"

Sputtered Ta-Si nanostructure film was investigated as a barrier material for Cu metallization. The TaSi film was deposited by co-sputtering of Ta and Si targets in Ar gas. The resistivity of the films varies from 238 $\mu\Omega\cdot\text{cm}$ to 900 $\mu\Omega\cdot\text{cm}$ with Si/Ta ratio from 0.256 to 2.172. XRD, HRTEM, XPS, and AES were employed to understand the crystalline structure, chemical structure, and atomic composition. Furthermore, we use C-V measurement to study the thermal stability of the TaSi film. The MOS capacitors of sputtered Cu or electroplating Cu/Ta-Si (30 nm)/methylsilsequioxane (MSQ), porous SiO₂ or SiO₂/p-Si structure were annealed at the temperature from 350°C to 500°C for 30 min in nitrogen ambient. The MSQ and porous SiO₂ films with thickness 200 nm were spin-coated on the Si wafer. The dielectric constant of these films was about 2.6. From the flat band shift and the variation of inversion capacitance, the diffusion performance can be evaluated [C3177]

"Studying on electron beam lithography technology"

We have worked out a method to obtain T-gate structures of sub-micron size with the Leica VB-5HR e-beam lithography system, tri-layer resists, and several levels of dose assignments, and applied this method to make GaAs microwave and millimeter wave devices and integrated circuits. Also, we have studied on lithography to fabricate fine lines of sub-micron even to nano-level, and we obtained the golden lifted-off features of 17 nm [C3178]

"Hybrid inverter circuits of nano-MOSFET and metallic-based SET"

In this paper, we give a novel choice of nanometer scale inverter. It is based on a nano-MOSFET as a drive transistor and a metallic-based SET (single electron transistor) as a load. The nano-MOSFET is assumed to have intrinsic silicon channel and metal source/drain. Applying a simple method based on ballistic transportation,

the device characteristics can be determined. On the other hand, SET, the device operating on the principle of Coulomb blockade effects, can be realized on a metallic base. By connecting the SET gate to its source, we can treat it as a normal resistance. Our simulation proved the two devices cooperated very well and we got the ideal characteristics of this inverter. These results are then compared with another form of inverter that we presented previously, and we conclude the advantages of both circuits at the end of the paper. [C3179]

"Electron field emission from silicon nanoprotusions"

Recently, enhanced field emission of electrons from a variety of nanostructured materials such as carbon nanotubes, and porous Si has been extensively studied for application to displays and other vacuum electronic devices. In this work, we have studied field emission of electrons by using a diode experimental setup without gate electrodes from the most fundamental Si nanostructure, i.e., Si nanoprotusions with both vertical and lateral sizes of 10–20 nm and the density of $3.5 \times 10^{11} \text{ cm}^{-2}$. The protusions were fabricated by our original self-organized selective oxidation technique, referred to as "nano-LOCOS". Although the Si protusions were quite small, high emission current was detected at low anode voltages, depending on the microscopic shape controlled by oxidation conditions. This result encourages us to develop "bright" and "highly functional" electron emitting devices using the Si nanosystem. [C3180]

"Microstructural investigations on aluminum titanate ceramics"

A field activated sintering technique (FAST) was applied to simultaneously sinter and react sol-gel amorphous, nano-sized, powders to form Al_2TiO_5 . Phase evolution by FAST was investigated by bright field contrast together with TEM imaging (HREM). A synergistic effect of increased homogeneity in the initial sol-gel powders and external field application resulted in enhanced densification and reaction to form the final Al_2TiO_5 product [C3181]

"The relative success of nanoscale RTD, SET and EQCA devices as replacements for CMOS at the system level"

A number of new concepts and devices which might replace CMOS were proposed, but often only device aspects are analysed. However the make or break for each device will be how successful it is at the system level. Here we are dealing with three newly proposed devices, namely Resonant Tunneling Diodes (RTDs), Single Electron Tunneling (SET) devices and electronic Quantum Cellular Automata (EQCAs), and present results for the system performance of three device technologies and CMOS. The comparison is made using a standard digital circuit architecture, namely a memory-adder model. The results show that the RTDs offer speed advantages over CMOS, but improvements in the circuit density are limited. The SET offer good packing densities but slow memory systems, whereas logic applications are still far away. The 'solid state' electronic QCAs will suffer both from effectively low packing density and low operating speeds in comparison to CMOS if conventional designs and a 2D architecture are used [C3182]

"Architectures for reliable computing with unreliable nanodevices"

As electronic devices get smaller and smaller, so the probability of errors in manufacturing increases, and the need to use fault-tolerant techniques. This paper compares the relative performance of four such techniques: R-fold multiple redundancy; cascaded triple modular redundancy; von Neumann's multiplexing method; and a reconfigurable computer technique. It is shown that manufacturing defect rates of the order of 0.01 to 0.1 will require enormous amounts of redundancy, of the order of 10^3 to 10^5 [C3183]

"Characterization of parylene coated combined scanning probe tips for in-situ electrochemical and topographical imaging"

The combination of scanning electrochemical microscopy (SECM) With atomic force microscopy (AFM) requires a combined scanning probe tip. In order to add the functionality of SECM, submicro- and nanoelectrodes have been integrated into AFM tips, using focused ion beam (FIB) based microfabrication techniques. Meeting the requirements for SECM measurements, needs to integrate the electroactive area within a certain working distance recessed from the apex of the AFM tip. Furthermore, a pinhole-free insulating layer is a major prerequisite for simultaneous topographical and electrochemical imaging applications. Parylene C was successfully applied for the insulation of the combined scanning probe tips. Cyclic voltammetry was performed, in order to characterize the electrochemical properties. Furthermore, FIB microfabrication procedures benefit from the advantageous properties of Parylene towards manufacturing integrated nanoelectrodes [C3184]

"Whole-chip ESD protection strategy for CMOS integrated circuits in nanotechnology"

On-chip electrostatic discharge (ESD) protection circuits are built in IC chips to protect the devices and circuits against ESD damage. But, ESD protection circuits constructed with scaled-down CMOS devices are very susceptible to ESD stress. Therefore, novel ESD protection solutions must be developed to overcome this reliability challenge for integrated circuits fabricated in nano-scale CMOS technology. The whole-chip ESD protection strategy for CMOS integrated circuits in nanotechnology has been proposed with two main methods. One is the substrate-triggered circuit technique used to effectively improve ESD robustness of devices in the nano-scale CMOS technology. The other is the novel design concept of "ESD buses" used to solve the internal ESD damage issue of CMOS IC with multiple and separated power lines. The internal circuits or interface circuits, realized by nano-scale CMOS devices, are more sensitive to such internal ESD damage issue. By using ESD buses, ESD current can be quickly discharged far away from the internal circuits or interface circuits of CMOS IC to achieve the goal of whole-chip ESD protection [C3185]

"Nano-scale Recessed Asymmetric Schottky Contacted CMOS"

A new CMOS device architecture named as Recessed Asymmetric Schottky Contacted CMOS (RASC-CMOS) has been proposed and simulated by using commercial version device simulator DESSIS 6.1. RASC-CMOS can eliminate the two critical drawbacks of conventional Schottky contacted CMOS (SC-CMOS): 1) unacceptable off-state current (>10 nA/ μm), 2) strong short-channel effects when the feature size of SC-CMOS scaled down to 10 nm. In the meantime, RASC-CMOS has kept the advantage of with extremely simplified fabrication process of SC-CMOS [C3186]

"Six-axis nano-positioning with planar magnetic levitation"

Nanoscale science and engineering is an emerging technological field and, has immense economic and societal impacts. This paper presents a high-precision magnetic levitation (maglev) technology that can be used in many crucial research activities in nanotechnology and, other precision applications dealing with delicate motions and forces. They include manufacture of nanoscale structures, atomic-level manipulation, assembly and packaging of microparts, vibration isolation for instrumentation, and seismic motion detection. A compact, lightweight, single-moving part that holds the specimen can be magnetically levitated-in all six degrees of freedom. This paper has demonstrated the applicability of this maglev technology in nanoscale science and engineering [C3187]

"Suppression of series parasitic resistance and observation of quantum effects in a silicon single-electron transistor"

We have fabricated a silicon point-contact channel SET with low series resistance using VLSI-compatible process. By narrowing only the point-contact region and suppressing the series parasitic resistance, the peak conductance as large as $8.8 \mu\text{S}$ and the silicon quantum dot as small as 7.6 nm are simultaneously obtained. Current staircase due to the large quantum level spacing is clearly observed at low temperatures. From numerical calculations, it is found that the staircase feature due to discrete quantum levels stands out even at room temperature in future silicon SETs with an ultra-small dot [C3188]

"Reliable prediction of deep sub-quarter micron CMOS technology performance"

We present a novel methodology for characterization of sub-quartermicron CMOS technologies. It involves process calibration, device calibration employing two-dimensional device simulation and automated Technology Computer Aided Design (TCAD) optimization, and, finally, transient mixed-mode device/circuit simulation. The proposed methodology was tested on $0.25 \mu\text{m}$ technology and applied to $0.13 \mu\text{m}$ technology in order to estimate ring oscillator speed. The simulation results show an excellent agreement with available experimental data [C3189]

"Single-sided grooved type or double-sided grooved type resonators manufactured by chemical etching process"

Novel quartz resonators of single-sided grooved type and double-sided grooved type in two steps shape were successfully manufactured by the chemical etching processes [C3190]

"The HARPSS process for fabrication of nano-precision silicon electromechanical resonators"

In this paper, radio frequency (RF) ultra-stiff electromechanical resonators are introduced and compared with their ultra-light counterparts. RF ultra-stiff resonators with dimensions in the low end of the micrometer scale can yield UHF frequencies (0.33 GHz) by operating at their higher order flexural modes. However, electrostatic actuation and capacitive sensing of ultra-stiff resonators will require nanoscale airgaps. The HARPSS (high aspect-ratio combined poly and single crystal silicon MEMS technology) fabrication process presented in this

paper is an all-silicon process that is capable of producing capacitive silicon resonators (poly and single-crystalline) with lateral gap spacing as small as 10 nm between the resonating structure and the silicon electrodes, without the need for nano-lithography [C3191]

"Micro and nano technologies in medical applications: a challenge"

This paper is aimed at the analysis of the main characteristics of recent micro-devices for biomedical applications. The massive use of microtechnologies is limited today to a reduced number of fields such as: telemedicine, bioanalysis, patient monitoring, implantable devices for functional regeneration, diseases treatment, signal recording, and minimally invasive surgery. The various aspects of the current tendencies are also analysed. We conclude with the biomedical devices that CNM has developed or is currently developing [C3192]

"Technology of silicon nano- and microelectrode arrays for pollution control"

A very simple fabrication technology for a new electrode array architecture with metal/dielectric pyramidal nanostructures and disk microstructures on silicon is described. This working electrode is intended for measurements and detection of metallic traces in liquid media [C3193]

"Modelling and simulations of nanostructures for Shipley SPR505A resist using PRIME process"

The Positive Resist Image by dry Etching (PRIME) process is a high resolution lithography system incorporating electron beam exposure, silylation and dry development. The process steps in PRIME with Shipley SPR505A resist have been modeled and simulations of nanostructures (50nm lines/spaces, 30nm single line) has been presented. The silylation process step in PRIME with SPR505A resist has been experimentally characterized using FT-IR spectroscopy [C3194]

"Novel pattern recognition-artificial neural networks applied to synthesis design of La³⁺-doped BaTiO₃ nanosize polycrystals"

This paper examines a series of La³⁺-doped BaTiO₃ (LBT) nanosize polycrystalline powders which have been synthesized by sol-gel process. The LBT crystalline size-which is affected by La³⁺-dopant content, drying temperature of quasi-gel and calcination temperature of dried gel-is the most essential factor that influences the humidity sensitivity and fabrication of the sensing element that composes the LBT polycrystals. The sensor, made of 15~25nm powders, displays consistent humidity sensitivity and feasibility of fabrication. Therefore, the samples are divided into two classes according to the crystalline size. Those with the crystalline size from 15nm to 25nm are considered as ideal, while those with the crystalline size less than 15nm and more than 25nm are inconclusive. In order to obtain parameters assuring preparation of the polycrystals with the crystalline size from 15 to 25nm, a combination of a novel pattern recognition (PR) and artificial neural networks (ANN) has been utilized to design the process parameters [C3195]

"A micro power supply for space micro-electromechanical systems using a high-temperature superconductor-magnet bearing"

This paper investigates the possibility of using a high temperature superconductor (HTS) for a micro power supply in space micro-electromechanical systems (MEMS). Feasibility studies have been carried out to develop a micro HTS-magnet bearing system which can be used for wear prevention and as a power supply. The rationale lies in the unique capability of the HTS to adapt to low temperatures, radiation, and vacuum environments in space, and to enhance system stability passively without power consumption. This micro power supply consists of three components: an HTS magnet flywheel energy storage system, a motor/generator, and a lithium micro battery. The generator armature planar coil will be deposited on the surface of the stator of the flywheel which encloses the HTS. The rotor of the flywheel has alternating permanent magnet poles for the motor/generator. The HTS flywheel has high angular momentum storage since its drag torque is nearly velocity-independent and extremely small, enabling high-speed rotation. Preliminary investigations show that the micro-sized superconductor magnet bearing system is compatible with current micro-fabrication technology and is ideal for preventing wear and producing power in space applications [C3196]

"Possibilities of electron beam nano-meter-scale fabrication of Si(111) using alkyl monolayers"

A novel process of electron-beam nanometer-scale fabrication on Si(111) wafer surfaces has been proposed on the basis of application of organic monolayers as the ultimately thin patterning media. The monolayers on Si(111) wafer surfaces composed of alkyl groups ($C_n H_{2n+1}$) prepared with the Grignard reagents were subjected to electron-beam patterning, and deposition of metals onto the electron-bombarded patterns by immersion into aqueous solutions containing Ni²⁺ or Cu²⁺ ions. This entire process has been put into practice

successfully as a benchmark test. The strength of alkyl-covered Si(111) surface against the processing environment such as in vacuum and aqueous solutions has been demonstrated [C3197]

"New trends in bio-nanorobotics using virtually reality technologies"

The scientific community has been working in the field of VR for some years now, having recognized it as a very powerful human computer interface. Although many of the described technologies have been developed into more or less mature products for robots acting in the macro-world, the nano-size of the robots poses extreme challenges and requires a complete rethinking of the visual and haptic perception of nanoworld. Using simulated nanoenvironments in VR, the operator can design and characterize through physical simulation the behavior of nano and bionanorobots. Adding haptic interaction, the operator can explore and prevent the problems of nano and bionano robots in their native environment. This article describes some of the emerging applications of VR currently underway in the field of bio-nanorobotics [C3198]

"Modeling of heat transfer for laser-assisted direct nano imprint processing"

The melting duration and molten depth are key information for laser-assisted direct imprinting, which raises issues about the melting & solidification induced by excimer-pulse-laser irradiating through unilaterally transparent binary materials. Considering the size-effect on thermal conductivity and phase-change of irradiated material, the thermal-contact resistance is taken into account to simulate and predict the melting behavior for this process. Results in this study indicate that the laser-annealing case as well as the perfect-contact case provides the upper-bound and the lower-bound values for the physical quantities involved in this process even without the detail information of the changing values of thermal-contact resistance [C3199]

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