Nanometer-scale Science and Technology Division
Room 6C - Session NS-MoM

Nanotechnology

Moderator: H.G. Craighead, Cornell University

9:00am **NS-MoM3 Nanotechnology - Fiction, Fad or Future?*, J.S. Murday,*** Naval Research Laboratory **INVITED**

Nearly 20 years have passed since Binnig and Rohrer published the first STM paper. This is the traditional gestation period for maturation of science into technology. What are the prospects for the science of nanostructures leading to new technology? There is already significant technology based on empirically derived nanostructures (for instance, heterogeneous catalysts, photographic film). A broad base of new nano-analytical tools is in place; nano-fabrication techniques are improving; new products are appearing in the market; and Federal funding agencies are taking notice. The National Science and Technology Council has formed an Interagency Working Group on Nanometer Science, Engineering and Technology. The working group will issue a report (June 1999) summarizing the opportunities, suggesting a national initiative in nanotechnology, and recommending a substantially larger federal investment in the science necessary to accelerate technologies built on nanostructures. This talk will briefly review the SOA in nanoscience, focus on highlighting examples where AVS pertinent nanoscience is making the transition into technology (computer memory-terabit/in2, biological sensors-molecular recognition/signal transduction, and nanostructured coatings-surface engineering), and conclude with a glimpse at potential federal agency funding.

9:40am **NS-MoM5 A Report on the Workshop "Vision for Nanotechnology R&D in the Next Decade"*, R.S. Williams,*** Hewlett-Packard Labs **INVITED**

More than 70 scientists, engineers, program directors and senior administrators from a broad array of disciplines, institutions and geographical regions gathered from January 27-29 in Washington, DC to discuss their views on the future of Nanotechnology research. This workshop was sponsored by the Interagency Working Group on Nano Science, Engineering and Technology (IWGN), which in turn has been charged by the Committee on Technology of the Office of Science and Technology Policy to identify the trends in nanotechnology, establish federal R&D priorities, and provide budget guidance to ensure that the potential of nanotechnology can be achieved in the US. Representatives from academic, corporate and government research organizations with backgrounds in dispersions and coatings, electronics broadly defined, composite structural materials, biology, medicine, energy and environmental sciences discussed technical issues and appropriate funding strategies. Given the large and heterogeneous nature of the workshop attendees, there were a surprising number of scientific themes that emerged as being crucial across the spectrum of research areas, such as ripening. If there were consensus issues among the attendees, they were most probably "Nanotechnology does not yet exist, but it will develop rapidly over the next decade", "avoid hype and extravagant promises", "the best federal investment strategy is to back a broad spectrum of high quality basic research and not focus on specific applications too soon", "focus the majority of funding on individual researchers and small interdisciplinary teams", and "the creation of nanotechnology will require the collaborative efforts of transdisciplinary teams and will in turn transform many traditional disciplines". This presentation will describe some of the accomplishments of current nanoscience research, opportunities for the future that were identified, and recommendations for funding agencies that came out of the workshop.

10:20am **NS-MoM7 Experimental and Theoretical Coincidence in Room Temperature Single Electron Transistor Formed by AFM Nano-Oxidation Process*, Y. Gotoh,*** *K. Matsumoto, T. Maeda,* Electrotechnical Laboratory MITI, Japan*; S. Manalis,* Massachusetts Institute of Technology*; J. Harris, C. Quate,* Stanford University

The experimental results of the room temperature operated single electron transistor (SET) were simulated using orthodox theory and 3 dimensional Poisson's equation. The simulated results coincided well with the experimental results. The planer type SET has been fabricated by oxidizing the surface of 2nm-thick titanium (Ti) metal that was on the atomically flat @ALFA@-Al@sub 2@O@sub 3@ substrate using the pulse mode AFM nano-oxidation process@super 1)@. The narrow oxidized Ti wire works as a tunnel junction for SET. The fabricated SET shows Coulmb oscillation characteristic even at room temperature at the drain bias of V@sub D@=0.3V when the gate bias was changed from V@sub G@=0 to 10V, and 5 oscillation peaks were observed with the periods of ~2V. The drain current was modulated by the gate bias and oscillates from 2.4pA to 3pA. Therefore, the modulation rate is ~20%. Using the orthodox theory, the experimental Coulmb oscillation was fitted using the parameters of the gate capacitance CG=8x10@super-20@F and the tunnel junction capacitances C@sub 1@=C@sub 2@=2.9x10@super -19@F. The simulated result represents well the experimental one, i.e. the position and the number of the Coulmb oscillation peaks and the modulation rate of the drain current coincide with the experiment of ones. Furthermore, tunnel junction capacitances were calculated by solving the 3D Poisson's equation for the structures of fabricated SET. In the calculation, the error tolerance of 0.01% was used. The calculated tunnel junction capacitances is found to be C@sub 1@=C@sub 2@=4x10@super-19@F which is almost coincide with the parameter used in the orthodox simulation. For further improvement of SET characteristics, an ultra sharp multi-wall carbon nanotube AFM tip was introduced for the AFM nano-oxidation process to reduce the oxide wire width down to 10~15nm to increase a tunnel current to improve S/N ratio of SET. 1) K. Matsumoto, Proceedings of IEEE Vol. 85, No. 4, p. 612 (1997).

10:40am **NS-MoM8 Study of the Super-resolution Near-field Structure for Optical Storage*, F.H. Ho,*** *D.P. Tsai, C.W. Yang,* National Chung Cheng University, Taiwan

We present the study of the mechanism of surface plasmons enhanced super resolution near-field structure, glass/SiN/Sb/SiN, for optical storage. Nonlinear near-field optical effects of the glass/SiN/Sb/SiN on the transmitted light spot were experimentally observed by a tapping-mode tuning fork near-field scanning optical microscope. Imaging results of the near-field intensity gradients showed that focused light spot through the super resolution optical near-field structure, glass/SiN/Sb/SiN, consists of a normal propagating term and an evanescent term resulting from the laser-excited surface plasmon of the Sb thin film. Results also demonstrated the spot size of the evanescent field intensity can be manipulated by the detecting sensitivity of PMT, while the spot sizes of the propagating intensity remained the same. The working principle of the reduction of the focused spot size and the transfer of near-field photo-thermal energy from Sb/SiN interface to the recording layer are explained.

11:00am **NS-MoM9 Nanometer-scale Science of Conjugated Polymer Interfaces*, A.R. Burns,*** *R.W. Carpick, D.Y. Sasaki,* Sandia National Laboratories

Highly-ordered organic films with integrated conjugated backbones and functionalized tail groups have considerable promise in several areas of nanometer-scale science and technology, especially sensor development. This technology brings together synthetic strategies, self-assembly and Langmuir-Blodgett deposition, and scanning probe characterization of both structural and optical responsivities. Specifically, we will discuss recent developments in the preparation and analysis of polydiacetylene monolayers on silica and mica substrates. As confirmed by atomic force microscopy and fluorescence microscopy, the monolayers consist of domains of linearly oriented conjugated backbones with pendant hydrocarbon side chains above and below the backbones. The backbones impose anisotropic packing of the hydrocarbon side chains which leads to a 300% friction force anisotropy. Phase transitions of the polymer induced by localized mechanical strain or chemical binding will also be discussed in terms of optical and morphological changes. Finally, we will discuss results concerning the incorporation of these polymers into three-dimensional nanocomposites. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.

11:20am **NS-MoM10 Fabrication of Nanostructures by Laser Focusing of Fe Atoms*, R.C.M. Bosch,*** *K. van Leeuwen, H.C.W. Beijerinck,* Eindhoven University of Technology, The Netherlands

We present an improved atom lithography method for the production of nanomagnetic wires and dots having well defined shape and separation. It is based on laser manipulated deposition of a supersonic beam of Fe atoms. The nodes of a 372 nm standing light wave act as a perfect lens for an incoming monochromatic parallel atomic Fe beam. The feature size of the deposited structures is therefore first of all limited by the quality of the incoming beam, and secondly by spherical aberration. A parallel beam is obtained by well known laser cooling techniques, but our improvement lies in the reduction of chromatic aberration by using a self-developed Fe evaporation source seeded with high pressure argon gas. The mixture will expand supersonically and due to adiabatic cooling it is in principle possible to obtain a beam with an axial velocity spread of less than 10%. The problem of spherical aberration will be solved with beam masking: a transmission grating with 100 nm slit sizes upstream of the standing wave allows only atoms near the nodes to be deposited. With the presented method we expect to reduce the structure sizes produced by conventional atom lithography methods and to break the 10 nm limit.

11:40am **NS-MoM11 One-dimensional Nanostructure of SiCN Single Crystal***, P.F. Kuo,* National Taiwan University, Taiwan*; C.-Y. Wen,* National Taiwan University*; F.G. Tarntair,* National Chio Tung University, Taiwan*; J.-J Wu,* Institute of Atomic and Molecular Sciences, Taiwan*; S.L. Wei,* Fu-Jen University, Taiwan*; K.H. Chen,* Academia Sinica, Taiwan*; L.C. Chen, Y.F. Chen,* National Taiwan University

Nanostructural materials have attracted wide attention due to its fundamental confinement effect and further applications of composites and microelectronics. From the standpoint of one-dimensional structures, there has been significant speculation about structures and properties of nanotubes and nanorods. In this paper, we report the growth of a novel one-dimensional single crystal nanorod comprised of Si, C, and N using microwave plasma enhanced chemical vapor deposition (MWCVD). The transmission electron microscopic analysis shows that the nanorods are of 1.5 µm in length and 50 nm in diameter, and the lattice images indicate that they are single crystals. High-resolution scanning electron microscope further confirms the nanorod diameter ranging from 10 to 60 nm, with hexagonal cross-section. The stoichiometry of the crystal was examined by the energy dispersive X-ray spectrometer (EDX) and the results showed a Si, C, N atomic ratio of 1:2:1. Detailed structural and stoichiometry information as well as optical and electronic properties measured by photoluminescence (PL) and electron field emission measurement are reported in this paper.

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