Tuesday Afternoon Poster Sessions

Nanometer Structures
Room: Exhibit Hall B2 - Session NS-TuP

Nanometer Structures A

NS-TuP1 Calibration Methods for Displacement and Cantilever Stiffness in AFM, *G.A. Matei, E.J. Thoreson,* ***N.A. Burnham***, Worcester Polytechnic Institute, *X. Chen,* University of Nottingham, *C.H. Hodges*, University of Leeds

The laser beam in our AFM was placed half on and half off a cantilever that was hanging freely above a reflective surface. The resulting two beams interfered and the interference could be detected at the photodiode, yielding a simple and accurate means of calibrating the scanner displacement. This approach will be extended to the calibration of the amplitude of oscillating cantilevers. Also, we compared the experimentally determined values of stiffness for ten cantilever probes using four different methods[1]. For rectangular silicon cantilever beams of well-defined geometry, the approaches all yield values within seventeen percent of the manufacturer's nominal stiffness. One of the methods is new, based on the acquisition and analysis of thermal distribution functions of the oscillator's amplitude fluctuations. We evaluate this method in comparison to the three others and recommend it for its ease of use and broad applicability.

[1] N.A. Burnham, X. Chen, C.S. Hodges, et al., submitted to Review of Scientific Instruments.

NS-TuP2 Atomic Force Microscope Assisted Oxidation of Zirconium Surfaces, ***N. Farkas***, *G. Zhang, S.F. Lyuksyutov, E.A. Evans, R.D. Ramsier,* The University of Akron, *J.A. Dagata*, National Institute of Standards and Technology

We present results from scanning probe oxidation of zirconium (Zr) surfaces using atomic force microscope tips in air. For both single-crystal and sputter deposited thin-films of zirconium, rapid oxide growth kinetics are replaced by much slower processes as a function of oxidation time (0 - 300 s). We track these kinetics vs. Zr film thickness (10 - 50 nm), relative humidity (25 - 60 %), and applied voltage (0 - 20 V). In addition, we are able to modify the nanolithographic process by incorporating nitrogen into the top 10 nm of the sputtered films. Our results contribute to a more comprehensive description of the nanolithographic process and complement efforts to model and control the oxidation of Zr surfaces.

NS-TuP3 Molecular Dynamics Simulations of Nanofluidics, ***K. Lee***, *S.B. Sinnott*, University of Florida

The design of ultrafiltration membranes using carbon nanotubes to allow gases to selectively pass through the membrane depends on the understanding of the diffusion and adsorption of the gases within the carbon nanotubes. The nanofluidics of hydrocarbons, oxygen, and carbon dioxide has been studied with molecular dynamics simulations in our research. These macroscopic behaviors can be simulated with multiple integrations of the interactions among the atoms in a system. The interatomic forces in the simulations are calculated using a classical reactive empirical bond-order hydrocarbon potential coupled to Lennard-Jones and Coulombic potentials. For a shorter time period, the location, the trace, and the orientation of the gas molecules in the nanotubes are affected by the diameters of the nanotubes, and the structures of the carbon nanotubes. The transport of gas molecules for a longer time period is described by nonequilibrium followed by equilibrium states. Until reaching the equilibrium state, the gas density in a carbon nanotubes increases on and levels off. During the nonequilibrium state, the gas molecules move back and forth through the nanotube. This behavior and the time for the level-off are affected by the concentration of gas molecules both in and outside of the carbon nanotube. It is found that the molecular volumes of the gas molecules and the composition of the gas mixtures also have an important effect on the separation behavior.

NS-TuP4 STM and STS Characterization of Silicon Phthalocyanines for the Molecular Quantum Dot Cellular Automata Implementationn, ***M. Manimaran***, *G.L. Snider, V. Sarveswaran, M. Lieberman*, University of Notre Dame

The surface characterization of organic molecules adsorbed on solid surfaces has been investigated intensively in recent years. In particular, the adsorption of long-chain substituted hydrocarbons (CH3(CH2)2X, X= CH3, OH, SH,S,SS, NH2, Cl, Br, I, etc on highly oriented pyrolytic graphite (HOPG) and Au surfaces was well studied because of their importance in wide range of applications in biology and molecular devices such as Quantum-dot cellular automata (QCA). QCA is a computation paradigm based on the Coulomb interactions between the neighboring cells. The prime idea is to represent binary information, not by the state of a current switch, but rather by the configuration of charge in a bistable cell. In its molecular realization the QCA cell can be a single molecule. Si-phthalocyanine (SiPc) is one of the promising candidates for the QCA. In this study, SiPc molecules, which are double-dot-like entities, are deposited on Au and Si(111) substrates initially. These molecules are then observed under UHV-STM to determine if the molecules would self assemble, and also to determine their electronic properties via voltage vs. current (I/V) measurements. In addition to the STM and STS studies, XPS, PL and ellipsometric results will be presented in this paper.

NS-TuP5 Substrate Temperature Dependence of Electrical Conduction in Nanocrystalline CdTe:TiO$_2$ Sputtered Films, ***S.N. Sharma***, National Physical Laboratory, India, *S. Kohli,* Colorado State University, *S.M Shivaprasad,* National Physical Laboratory, India, *A.C. Rastogi*, University of Massachusetts

TiO$_2$ thin films with high volume fraction (~ 50-60 %) of CdTe nanoparticles were prepared by rf magnetron sputtering from a composite TiO$_2$:CdTe target. Variations in the substrate temperature, T$_S$ (room temperature-RT and 373 K), produces two distinct structural regimes with different electrical properties in thermally treated TiO$_2$ thin films: (i) a metallic regime for low T$_S$ films where the CdTe/Cd grains touch each other and form a metallic continuum. Here, homogeneous, ordered and electrically-continuous structure was obtained. Here, due to the presence of large-scale coalescent islands of CdTe/Cd, three-dimensional network of crystallites could be realized. Such films exhibited positive temperature coefficient of resistance. For metallic regime films, electrical conduction is essentially due to electrical percolation through CdTe/Cd crystallites embedded in an amorphous TiO$_2$ matrix. XPS studies indicated the segregation of metallic Cd upon thermal treatment which were responsible for metallic-type of conduction exhibited by these films. (ii) a non-metallic regime for high Ts films in which small isolated particles of CdTe/Cd are dispersed in an amorphous matrix. Here, highly disordered and electrically-discontinuous structure was obtained and thus formation of CdTe network could not be realized. The formation of oxides on the surface of the CdTe/Cd crystallites acts as an electrical insulation and thus, the conduction is thermally activated. The electrical conduction in high T$_S$ films is essentially by hopping mechanism thus indicating transfer of charge carriers via thermally activated tunneling. Such films exhibited negative temperature coefficient of resistance.

NS-TuP6 Nanolithography and Biofunctionalisation for Cell Adhesion Studies, *A. Szucs,* ***M. Arnold***, *Ch. Geierhaas, J.P. Spatz*, University of Heidelberg, Germany

Periodic and artificial lateral nanostructures with micrometer or nanometer spacings have been prepared through the combination of a top-down approach (electron beam lithography) with a bottom-up approach (formation and compartmental localization of metallic and semiconductor nanodots within block copolymer micelles). E-beam lithography was used to construct patterned templates with characteristic spacings greater than 200 nm of coarse prestructures. Within these structures, Au nanoparticles and/or quantum dots (Q-dots) (CdS, CdSe and CdTe) in the size range of 2-8 nm could be positioned with a precision of approx. 10 nm by means of a self-assembling polymer micelle. The particle size was controlled by the length of the reverse micellar core constructing polymer and the salt loading inside the core. Specifically, it was obtained by casting a solution of HAuCl4 and/or Cd salt loaded block copolymer micelles onto the prestructured resist film. Due to capillary effects and steric hindering, the particles are centered within the prepatterned holes and at the edges of prestructured lines. Subsequent lift-off of the resist allows the removal of all micelles with the exception of those that are in direct contact to the underlying substrate. The block copolymer is then removed by plasma etching, which strips the polymer micelle and reduces the gold salt to gold thereby leaving behind nanoscopic dots or lines of gold in a defined array. These nanostructured interfaces are used as platform for biofunctionalisation of solid interfaces. The surfaces are used as a tool to investigate cluster formation of focal adhesion associated proteins of fibroblasts.

NS-TuP7 In situ STM Study on Electrochemical Formation and Desorption of Self-assembled Monolayer in Ethanol Solution Containing KOH and Alkylthiol, ***K. Uosaki***, *H. Wano*, Hokkaido University, Japan

Oxidative formation and reductive desorption of self-assembled monolayer (SAM) of alkylthiol in ethanol solution containing KOH and various concentration of alkylthiol was investigated by in situ STM. Cyclic voltammograms show the formation process is slower than the desorption process. When the concentration of the thiol was very low (~ micro M), no vacancy island (VI) was observed even in positive potential region where SAM formation is expected. As more thiol was added at the positive potential region, the growth of VIs, i.e., SAM, was observed. The VIs disappeared and herringbone structure appeared on the surface as potential became more negative than the certain value, showing the restoration of the reconstructed, i.e., clean, surface. The herringbone structure became clearer with time. When the potential was scanned positively, disappearance of the herringbone structure and the growth of the VIs were observed. Drastic change of step lines reflecting the higher mobility of gold atoms was also observed during the formation and desorption of the SAM.

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