

Tuesday Afternoon Poster Sessions

Nanometer-scale Science and Technology

Room: 4C - Session NS-TuP

Nanometer-scale Science and Technology Poster Session I

NS-TuP1 Orderly Fabrication of Nanometer-Scaled Triangular Structure using Bridge Phenomenon of Polystyrene Beads, B.K. Lee, K.S. Kim, J.H. Lee, N.H. Kim, Y.H. Roh, Sungkyunkwan University, Republic of Korea

Recently, nanometer-scaled materials have used for fabrication of nanostructure. Polystyrene bead (PSb) has many advantages for fabrication of nanostructure. For example, the PSb could fabricate the particular pattern array structures using for its self-assembled monolayer property. The PSb could be integrated with the established semiconductor process technologies because the PSb has excellent compatibility with silicon substrate. In this experiment, a spin coating was used for well-ordered array of the PSb. The PSb could be reduced its size using an oxygen plasma ashing process. During the plasma ashing process, the bridge phenomenon was occurred between the adjacent PSBs according to the plasma ashing conditions. The main reason for the occurrence of PSb bridges during the plasma ashing process is estimated that the PSb on the silicon surface was not sufficiently ashed by plasma. The ashed PSBs showed the triangular structures and the adjacent bridge distance was under 35 nm. The metal thin film was deposited on the bridges of the PSBs and then the PSBs as a deposition mask were removed by ultra sonication process. After the metal deposition on the ashed PSBs mask, we could obtain the nanometer-scaled triangular island less than 30 nm with the well-ordered array. Consequently, the triangular island would be applied to the nanometer-scaled devices such as single-electron transistor and biosensors.

NS-TuP2 Deposition of Gold Nanoparticles on HOPG using Atmospheric Plasma, F. Demoisson, Universite Libre de Bruxelles, Belgium, **M. Raes, J. Vereecken,** Vrije Universiteit Brussel, Belgium, **F. Reniers,** Universite Libre de Bruxelles, Belgium

The interest for gold nanoparticles in the field of nanocatalysis and of nanosensors is growing. Nanotubes covered with gold nanoclusters could present interesting properties in these fields. However, due to the weak carbon-gold bond, the adhesion of this metal to carbon is not trivial. It is generally accepted that the carbon surface must be activated, either by the creation of surface defects and/or by the adsorption of reactive species, such as oxygen containing groups. Most of the time, activation is done using wet chemistry techniques, such as hot nitric acid solutions. Some studies present activation and deposition experiments realized using vacuum techniques, with ion guns, low pressure plasmas, and/or thermal evaporators. In this preliminary study, we used highly oriented pyrolytic graphite (HOPG) as a model surface that could present the same chemical properties as the one of carbon nanotubes. An atmospheric plasma torch was used to activate the HOPG surface and to realize the gold deposition. The atmospheric plasma torch runs in the RF mode (13.56 MHz), using argon as the main gas. Oxygen was added as secondary gas, in order to provide the active species able to activate the surface. The plasma post discharge was spatially characterized by optical emission spectrometry. Immediately after activation, metal particles were injected into the plasma post-discharge. The surface Au/C elemental composition was analysed using XPS and shows the presence of gold, whereas field emission gun scanning electron microscopy allowed to study the size distribution of the gold particles on the surface as a function of the plasma parameters. This work is financially supported by the Nano2Hybrids (EC-STREP-033311) and PAI 7/3 (Plasma surface interactions - Belgian federal government) projects.

NS-TuP3 Laser Transfer of Organic Molecules through a Liquid Layer, Y. Pihosh, M. Goto, A. Kasahara, M. Tosa, National Institute of Materials Science (NIMS), Japan

Previous results of implantation of Coumarin 6 (C6) molecules on a target polymer surface by laser molecular implantation technique showed that the achieved minimum size of dots could be 3 μm in diameter. However, the implantation of organic molecules into conductive organic or inorganic materials on the nanometer scale is one of the challenging problems in materials research that has to be solved. Here, we report the process of laser molecular implantation of pyrene acid and pyrene sublimed molecules onto different materials by generating a laser-induced water channeled jet through a liquid-filled space-gap between the source film and target materials. This process leads to significant reduction in the size of

implanted organic molecular dots to a sub-micrometer region on the surface of solid materials such as glass and copper. The pyrene source films were prepared by means of thermal evaporation onto a cover glass with the thickness of about 600 nm. The source film and the target were brought into contact, and the distance between them was filled with liquid. A four nanosecond pulse laser beam was focused on the surface of the source film by special array of lenses, and those photo-excited organic molecules. As a result, the molecules could be ejected from the source film in a form of a plume through a strait path, which was created by laser induced plasma. Later the molecules were implanted onto or into the target materials in the form of dots or rings depending on laser fluence. Those experiments focused on the implantation process of pyrene organic molecules in the submicron region on glass and copper substrates through polar and non-polar liquids. The size of the smallest implanted pyrene acid dots implanted through water and diiodomethane layer was estimated to be about 0.4 μm and 0.3 μm at laser fluences of 235 Jcm^{-2} and 326 Jcm^{-2} , respectively. From fluorescence spectra it was noticed that the implanted molecules did not decompose during the implantation process no matter which liquid filled the gap. In the case of pyrene sublimed molecules it was found that implantation occurs only through a water layer, and, also, that the implanted dots have a very short life time.

NS-TuP4 Effect of Surface Potential on Formation of DNA-Templated Gold Nanowires by pH Change of Gold Nanoparticles, S.W. Cha, J.-S. Kim, H.J. Kim, N.H. Kim, Y.H. Roh, Sungkyunkwan University, Republic of Korea

Biological molecules such as DNA are especially useful as the material for the nanoscale electronic construction because their strand is possible to regulate and their width has nanometer-size diameter of about 2 nm. And also, the negatively charged phosphate group in DNA is possible to bind the surface-functionalized gold nanoparticle (AuNP). However, the location of AuNP with the uniform interval along DNA molecules as template is generally considered to be difficult because precise control of the electrostatic force for conjugation between negatively charged DNA molecules and positively charged AuNPs is hard. In this study, we developed a new method to control the interval between AuNPs on stretched DNA molecules by changing pH of oxidized aniline-capped AuNPs (AN-AuNPs). DNA molecules were stretched and fixed on 3-aminopropyltriethoxysilane (APS) coated Si wafer by the tilting method. Then, pH of AN-AuNPs solution was changed by adding NaOH solution, and DNA molecules were treated with AN-AuNPs solution for the certain time. As NaOH solution was added in AN-AuNPs solution, the surface electric charge of AN-AuNPs was decreased. Atomic force microscopy (AFM) was used to analyze the intervals of AN-AuNPs attached on DNA molecules. The surface electric charge of AN-AuNPs was measured with the change of pH by the Zeta-potential measurement to confirm the interval of AuNPs when the surface electric charge of AN-AuNPs was changed. The effect of AN-AuNPs size on the intervals of AN-AuNPs was also investigated because the AuNPs would be aggregated with the change of pH of AN-AuNPs.

NS-TuP5 Nanostructured Growth of Cobalt on Cu(775): An STM and Photoemission Study, M. Yilmaz, N. Zaki, S. Wang, K. Knox, D.V. Potapenko, J. Dadap, R.M. Osgood, Columbia University, **T. Valla, P. Johnson,** Brookhaven National Laboratory

Vicinal metal surfaces have attracted much attention in recent years as templates for self assembled nanostructures. We will present an STM and photoemission study of Co/Cu(775). Using STM, we observed that the substrate acts as a template for the growth of Co. Cobalt grows in the form of anisotropic islands, the structure of which changes with coverage. The effect of these nanostructures on the surface electronic structure is investigated by means of high resolution angle resolved photoemission spectroscopy (ARPES). At very low coverages, cobalt alters the modulation plane of the Cu surface state from surface modulation to terrace modulation. As the coverage increased an additional Cu derived surface state at a higher binding energy appears. Both states are suppressed as more cobalt is deposited on the surface. Cobalt d-band features are relatively flat and consistent with experiments performed on other Co/Cu systems.

NS-TuP6 Influence of Preparation Condition on Electrical Properties of Cobalt(Co²⁺)-Metallic-DNA Molecules, S.D. Cheon, N.H. Kim, Y.H. Roh, Sungkyunkwan University, Korea

Recent works have showed many attractive interests in the formation of nanowires to make nano-device using the deoxyribonucleic acid (DNA) molecules. Because of DNA molecule has narrow width (2nm) and the length of DNA easy to control. Metallic DNA (M-DNA) is a modified DNA by incorporating divalent metallic ions (i.e., Zn²⁺, Co²⁺, Ni²⁺, etc.) to the

each base pair of B-DNA. It is one of the methods to form the metallic nanowires with metallic electrical conductivity by contrast with B-DNA of semiconductor like electrical properties. M-DNA has the higher and the more stable current-voltage (I-V) characteristic than B-DNA. Most experiments of electrical properties of M-DNA were made up by Zn-M-DNA. Cobalt and nickel divalent ions are generally known to be also possible to make M-DNA. Particularly, cobalt (Co^{2+}) is comparatively easy to make M-DNA because of its good synthesis rate and fast incorporating speed. In this work, Co-M-DNA could be made using poly(dG)-poly(dC), poly(dA)-poly(dT) or lambda DNA. The Co-M-DNA was prepared with the various conditions such as concentration of divalent metallic ions, preparation pH and temperature. The Co-M-DNA was prepared with heating processes, which contributed to decrease of incorporating time. The prepared Co-M-DNA molecules were attached on Au electrodes with the nanometer size gap. The current through Co-M-DNA measured on vacuum (10^{-2} torr) to minimize humidity effects by HP4145 semiconductor parameter analyzer. The current through Co-M-DNA showed the metallic electrical properties and larger conductivity than B-DNA. The conductivity of Co-M-DNA became larger by preparation over pH 8. Furthermore, the conductivity of M-DNA was affected by Co^{2+} concentration.

NS-TuP7 A Study on the Patterned Molecular Wires Based on Carotenoids by Electrostatic Force Microscopy and I-V Measurement. J.W. Yoo, J.W. Kim, Y.J. Choi, Y.S. Kim, S.H. Koo, C.J. Kang, Myongji University, Korea

Electrical properties of single carotenedithiol molecules lithographed on Au by micro channel have been investigated by electrostatic force microscopy (EFM) and current versus voltage (I-V) measurement. The Carotenedithiol molecules have three different species of end-groups substitutive. To make a wire pattern, polydimethylsiloxane (PDMS) micro channel carrying carotenedithiol molecules are used and the molecules are inserted into an octadecane monolayer that is previously patterned on Au substrate. After removing the PDMS channel, EFM and I-V measurement was performed on the remained wire pattern. For the efficient microscopy, we adopted cantilever oscillation method using Lorentz force. The results show that the organic molecules of carotenoid based patterned nano wires can be a candidate of the element for nano devices.

NS-TuP8 Real-time Single-molecule Detection on Random Arrays for Biosensing Applications using Total Internal Reflection Fluorescence. A. Gunnarsson, P. Jönsson, R. Marie, J. Tegenfeldt, F. Höök, Lund University, Sweden

Development of ultrasensitive biological sensors has attracted significant scientific interest due to its many possible application areas such as biomedical diagnostics, proteomics and forensic analysis. DNA sensing using nanoscale devices based on electrical^{1,2} or optical^{3,4} detection has shown great promise for achieving high sensitivity and specificity. We report of a novel biosensor assay capable of detecting non-labeled low-abundant DNA targets based on surface adsorption of lipid vesicles through DNA hybridization. Using total internal reflection fluorescence (TIRF) microscopy, single DNA molecule detection at 10 fM concentrations is achieved. Various biomolecules besides DNA can be probed with the assay, including soluble and membrane proteins utilizing the lipid bilayer of the vesicles. Not only achieving ultra-sensitive detection, the novel approach also offers great potential for studies of biomolecular interactions on a single molecule level in real time.

¹ Hahn, J.; Lieber, C. M. *Nano Letters* 2004, 4, (1), 51-54.

² Brousseau, L. C. *Journal of the American Chemical Society* 2006, 128, (35), 11346-11347.

³ Bailey, R. C.; Nam, J. M.; Mirkin, C. A.; Hupp, J. T. *Journal of the American Chemical Society* 2003, 125, (44), 13541-13547.

⁴ Ho, Y. P.; Kung, M. C.; Yang, S.; Wang, T. H. *Nano Letters* 2005, 5, (9), 1693-1697.

NS-TuP9 Siloxane, including Amine Terminal, Coated Stable Silicon Nanoparticles for Interaction with Negative Charged Materials. B.-Y. Jeong, SKKU Advanced Institute of Nanotechnology (SAINT), Sungkyunkwan University, Republic of Korea, J.-W. Park, Sungkyunkwan University, Republic of Korea, J.-S. Kim, SAINT, Sungkyunkwan University, Republic of Korea, N.H. Kim, Y.H. Roh, Sungkyunkwan University, Republic of Korea

Silicon nanoparticles (Si NPs) have many interesting electronic properties such as controllable electron mobility and energy band-gap through doping impurities despite their nanometer-scaled size. They are widely used in LED, photo-luminescent label, sensor, etc. Si NPs could be also applied to nano-size semiconductor. However, pure Si in nature makes natural oxide-layer. Moreover, Si NPs which were not functionalized lost their characteristics of nanoparticles for aggregating each other because the pure Si has unsatisfactory stability. Therefore, the surface of Si NPs should be modified in order to disperse and stabilize Si NPs. In this study, Si NPs were coated by siloxane that has amine terminal to stabilize and modify the surface of Si NPs to the positively charged surface coincidentally. It led to

prevent an aggregation and chemical reactions of surface. After treatment, Si NPs were dispersed in solution and had positively charged surface. The raw Si NPs were treated with piranha etch to remove the oxide layer and make a hydroxyl surface. In order to induce hydrosilylation, we added 3-aminopropyltriethoxysilane with gentle stirring. TEM was carried out to check the rate of dispersion. EDX and FTIR analyses were performed to confirm the hydrosilylation reaction. Zeta-potential was measured in order to estimate the charge of particle surface. Consequently, we expected that the stable siloxane-coated Si NPs with positively charged surface have possible applications to conjugate with phosphate of DNA or other polymer with negative charge.

NS-TuP10 Fabrication of Well-defined Microdomains Composed of Aldehyde- and Carboxy-terminated Self-assembled Monolayers. A. Hozumi, National Institute of Advanced Industrial Science and Technology (AIST), Japan, H. Taoda, T. Saito, AIST, Japan

Organosilane self-assembled monolayers (SAMs) have been widely applied to the artificial control of surface chemical functionalities. Among the various types of SAMs, both aldehyde (CHO)- and carboxy (COOH)-terminated SAMs are of particular interest owing to their chemical reactivities to biomolecules. Here, we report on the fabrication of microdomains composed of CHO- and COOH-terminated SAMs on a Si substrate covered with native oxide. The cleaned substrate was first exposed to a vapor of 12.5 vol % solution of triethoxysilylundecanal (TESUD) diluted with absolute toluene for 3 h at 403 K. This vapor phase treatment produced the CHO-terminated SAM on the native oxide/Si surface. The thickness of this SAM was estimated by ellipsometry to be about 1.2 nm. Next, some of the samples were irradiated for 1-60 min with 172 nm vacuum UV light in air. Due to this treatment, the hydrophobic surface became hydrophilic gradually with irradiation time. Although film thickness remained almost unchanged even after irradiation for 25 min, water-contact angle decreased from 86 degree to about 25 degree. Both contact angle and film thickness decreased markedly after around 25 min and reached their minimum of 5 degree or less and 0.3 nm, respectively, at the irradiation time of 60 min. We further confirmed by X-ray photoelectron spectroscopy and attenuated total reflection spectroscopy, the irradiation time of 25 min was determined the optimum time to yield reproducible COOH-terminated SAM. Finally, the CHO-SAM was irradiated site-selectively through a photomask. As confirmed by lateral force microscopy, the microstructures composed of 5 micron x 5 micron square features photoprinted on the CHO-terminated SAM surface were clearly imaged through the friction force contrast between the photoirradiated and masked regions. The former regions were expected to have been converted to COOH-terminated SAM.

NS-TuP11 Conducting Polymer Nanofilm Growth on a Nanoscale Linked-Crater Pattern Fabricated on an Al Surface. H. Kato, S. Takemura, A. Ishii, Y. Takarai, Y. Watanabe, T. Sugiyama, T. Hiramatsu, N. Nanba, Kanto Gakuin University, Japan, O. Nishikawa, M. Taniguchi, Kanazawa Institute of Technology, Japan

A nanoscale linked crater structure was fabricated on an Al surface by wet chemical and electrochemical processes. The surface of an Al plate was treated with Semi Clean and Semico Clean in order to create crater-shaped erosion on the surface. The successive electrochemical anodization in H_2SO_4 solution created a nanoscale finer linked-crater structure on the surface. The authors conducted the nanofilm growth of conducting polymer polythiophene on the nanoscale structured Al surface by the electrochemical polymerization method. The electrochemical polymerization was performed in acetonitrile containing thiophene monomer and $(\text{Et})_4\text{NBF}_4$ as a supporting electrolyte and the polymerization on the linked-crater surface was conducted by applying positive voltage to the Al plate. The dynamic force microscopy (DFM) image of the Al surface after the polymerization process suggested that the polymer was grown on the nanoscale linked-crater structure. In the DFM measurements, the dimmer contour image of each crater was still recognized even after the polymerization process was fulfilled suggesting that the polymer film was grown on the Al surface. The cross section analysis of the DFM measurement demonstrated that the nanofilm was grown on the linked crater because the crater depth became shallow. X-ray photoemission spectroscopy (XPS) measurement also supported the polymer growth because C 1s and F 1s due to the polymer origin were detected. Furthermore, the authors tried to inject copper phthalocyanine (CuPc) molecules into the polythiophene nanofilm on the nanoscale structured Al in order to functionalize the nanoscale hybrid materials. The XPS measurement detected C 1s, N 1s and Cu 2p lines due to the injected CuPc molecules. This work was supported by High-Tech Research Center Project aided by MEXT.

NS-TuP12 Fabrication of Nanoscale Organic Patterns on a Highly-Oriented Grooved Structure Created on an Electrochemically Treated Aluminum Surface. *H. Kato, Y. Watanabe, S. Takemura, S. Kimura, D. Okumura, R. Nakano, T. Sugiyama, T. Hiramatsu, N. Nanba,* Kanto Gakuin University, Japan

The surface of an aluminum plate was treated with a combination of chemical and electrochemical processes. A chemical treatment with acetone and a successive electrochemical process created a nanoscale highly-oriented grooved structure on an aluminum surface. The distance between the oriented lines was estimated as 30-40 nm by dynamic force microscopy (DFM) measurements. The present work intended to make an organic-inorganic nanoscale pattern using this nanoscale structure. Copper phthalocyanine (CuPc) and fullerene C60, which were highly-functional molecules, were selected in fabrication of nanoscale patterning. CuPc and C60 molecules were deposited on the highly-oriented line-structure on Al. A toluene droplet containing CuPc molecules was cast on the Al plate and extended on the surface. CuPc deposition on the Al surface was made by evaporation of toluene. Cross section analysis of the DFM measurements clarified that each aligned groove was filled with CuPc molecules because the depth of the channel became shallow and in some area the row width became narrower after the CuPc deposition. X-ray photoemission spectroscopy (XPS) measurements clarified that N 1s and Cu 2p lines appeared, which also supported the CuPc deposition on the nanoscale structure creating a nanoscale organic line-pattern. The spectral profile difference of Al 2p pre- and after deposition of CuPc suggested the molecular-surface interaction. Furthermore, the authors tried to make a polyaniline nanowire along the row channel fabricated on an Al surface. A droplet of HCl solution containing aniline molecules was cast and extended on the nanoscale-structured Al plate. Successively, a droplet containing APS was put and extended on the surface in order to trigger the polymerization in the nanoscale area. The DFM and XPS measurements clarified that aniline molecules were polymerized in the channel. This work was supported by High-Tech Research Center Project aided by MEXT.

NS-TuP13 Quenching of Photoluminescence in Silicon Oxide Layers with Silicon Nanocrystals under Ion-Beam Irradiation: Analysis of Experimental Data. *V.A. Stuchinsky, S.G. Cherkova, G.A. Kachurin, D.V. Marin,* Russian Academy of Sciences

A quantitative analysis of experimental data on photoluminescence (PL) quenching in silicon oxide layers with embedded Si nanocrystals (nc's) under ion-beam irradiation is presented. The analysis was performed using the data of¹, obtained for an nc-system with mean nc size $R=2.9$ nm irradiated with 2 MeV He, Ge, and Au ions, and our data obtained for an nc-system with $R=3.8$ nm, irradiated with 130-200 keV He, F, and P ions. A method to allow for the PL lifetime degradation is proposed, which can be applied if the available dataset for a particular nc-system contains data obtained using irradiation of this system with light ions. A simple model is considered to predict the number N_{lum} of luminescing nc's versus the fraction η of atoms displaced in the system at low irradiation doses with allowance for the density of collision cascades and the size distribution of nc's. In this model, the well-known expression for N_{lum} vs η in the case of random rare displacements is used (see, e.g.,¹), with the density of atomic displacements corrected for the damage factor of individual nc's. The experimental PL quenching curves were used to determine the average number of stable nonradiative centers introduced into one nc (N_{exp}). The quantity N_{exp} was then compared with the mean number N of displacements per nc obtained in a computer analysis of TRIM simulation data on 3D coordinates of displacements. The yields N_{exp}/N of stable nonradiative centers with respect to primary displacements in the nc-systems irradiated with the various ions were determined. The obtained values suggest that in dense collision cascades close vacancies choose to combine in divacancies, whereas in rare cascades they prefer to form nonradiative centers individually, possible coming to the nc/matrix interface with the formation of dangling bonds there. A physical interpretation is given to the curves of PL lifetime versus the damaged fraction of nc's. The exciton tunneling times between adjacent nc grains in the nc-systems under consideration were evaluated (120 and 15 μ s for the systems with $R=2.9$ and 3.8 nm). Based on these values, estimates of the decay length of the excitonic wavefunction into the dielectric matrix, and the excitonic recombination cross section at deep traps introduced by ion-beam irradiation in the host dielectric, were obtained.

¹ D. Pacifci et al. Phys. Rev. B 65, 144109 (2002).

NS-TuP14 Segmented Nanowire Fabrication Through Templated Electrodeposition. *A.J. Murray, S. Evoy,* National Institute for Nanotechnology, Canada

Metal oxide nanowires have recently attracted considerable attention in electrochemical sensing. Templated electrodeposition of metals within porous aluminum oxide (PAO) membranes has proven to be a simple and reliable method of nanowire synthesis.¹ The PAO self ordered pore array

consists of honeycomb packed hexagonal cells with central cylindrical pores. Pore diameters exhibit high uniformity across the membrane can be easily tailored from 4 to 400 nm, while a pore depth of several hundred nanometers has been achieved. Electrodeposition of WO_3 has been explored for its electrochromic effects. Application of WO_3 to gas sensing was first explored by Reyes et al.² We here report on the development of WO_3 segmented nanowires for chemical sensing. The basic layout of these sensing structures consists of a short metal oxide segment intercalated between gold electrical contacts. During the initial step, a 500 nm silver layer is sputtered onto the back of Whatman Anodisc 25 PAO filters. The resistive nature of aluminum oxide forces wire growth to initiate at the seeding layer, the deepest point within each pore, and continue towards the surface of the membrane. Silver (Technic Inc. Cy-less Silver RTU Plating solution) is backfilled into the pores and acts as a sacrificial contact, restricting gold and metal oxide growth to a uniform portion of the membrane. 3 μ m of gold is subsequently deposited from Technic-Gold 25 E (Technic Inc.) at a current density of 250 μ m/cm². A 0.1 molar aqueous sodium tungstate (Na_2WO_3) solution is then prepared and subsequently deposited at 0.5 mA/cm². Plating is completed with a final 3 μ m Au deposition. The resulting wires are then released by selective etching of the silver seeding layer and the porous alumina template. Extensive structural characterization of these nanowires using XPS, SEM and Auger will be presented. We plan to present both morphological material analysis as well as preliminary electrical response and chemical sensing results.

¹ A. Kolmakov, Y. Zhang, G. Cheng, M. Moskovits, "Detection of CO and O₂ using tin oxide nanowire sensors", Adv. Mater. 15(12), 997-1000 (2003).

² L.F. Reyes, A. Hoel, S. Saukko, P. Heszler, V. Lantto, C.G. Granqvist, "Gas sensors of pure and activated WO_3 nanoparticle films made by advanced reactive gas deposition", Sensors and Actuators B 117, 128-134 (2006).

NS-TuP15 Local Gating Behaviors in Nanowire Heterojunction Transistors. *J.-H. Lim, H.J. Ji, G.E. Jeong, G.T. Kim, J.S. Ha, S.-J. Kahng,* Korea University

Electronic transport properties of ZnO nanowire transistors were studied with atomic force microscope (AFM). The nanowire transistors were fabricated with ebeam lithography and characterized in a probing system embedded in the AFM. Clear gate dependence was observed in the source-drain current by using the non-local back-gate in the transistor. When Ti-Pt-coated AFM tip was used as a local and mobile gate, it was observed that the gating behavior is strongly dependent on the position of the local gate. The transistor could be made on and off repeatedly with the AFM tip locating above the nanowire heterojunction, implying that the active region in the transistor behavior is mostly confined to the small junction area.

NS-TuP16 Nanoindentation Rate Depend Mechanical Properties of Nickel and Titanium. *E. Tam, P. Berke, T.J. Massart, M.P. Delplancke-Ogletree,* Universite Libre de Bruxelles, Belgium

Rate dependent nano-indentation experiments have been performed on pure polycrystalline nickel and titanium and also on anodized titanium samples. During indentation, the load is linearly increased, then held constant for various intervals of time then reduced linearly to zero. The extent of "creep", sample displacement at constant load, varies with the loading rate. Finite element calculations have been performed to model these experiments. Using time independent material properties, the slope of the loading curve is significantly underestimated. When rate-dependent material properties are used in the model calculations accurate load slopes and creep behavior are obtained. Additional experiments have been carried out to analyse the effect of sample roughness and indentation depth. Implications for determination of material properties through nano-indentation will be discussed.

NS-TuP17 Flipping of Atomic Image Contrast of Graphite. *J. Choi, G.S. Khara,* Wayne State University

Flipping of atomic image contrast of graphite is studied by using scanning tunneling microscopy (STM) and spectroscopy (STS). Tunneling gap-distance, gap-voltage and bias polarity play an important role in the flipping of atomic image contrast. The study revealed that the flipping of atomic image contrast is natural because of the electronically active and mechanically soft beta-carbon atoms of graphite. The brightest contrast in the scanning tunneling microscopic images does not always represent a specific site of graphite such as beta-site. The flipping mechanism of atomic image contrast will be discussed.

NS-TuP18 Construction of a Ultra Low Temperature Scanning Tunneling Microscope System¹. *Y.J. Song, S.R. Blankenship, J.N. Crain, J.A. Stroscio,* National Institute of Standards and Technology

We describe the design and construction of an ultra-low-temperature (20 mK), high magnetic field (15 T) scanning tunneling microscope (ULT STM) system. This ULT STM consists of an ultra-high-vacuum-compatible dilution refrigerator (DR) and associated UHV systems. The DR was

designed and constructed to allow two independent modes of ^3He condensation: a traditional 1K pot condenser, or a Joule-Thomson condenser for possible lower noise operation. The system includes extensive vibration isolations and RF shielding. We describe the cooling power characteristics and temperature measurement system of this versatile DR, which reaches a base temperature of 10 mK without STM running. For STM/STS measurements a custom-designed STM module suitable for operation at mK temperatures is described. The STM body is made from coin silver which is rigid and thermally conductive in the mK regime. The whole STM module can be transferred from the upper, room-temperature chamber where the sample and tip can be easily exchanged. The sample holder has five isolated electrical contacts which are also used for kinematic mounting of the sample. This allows 4-probe electrical measurements to be performed simultaneously with STM measurements for microscopic transport studies. This STM module has ± 2 mm of x and y travel and in-situ deposition capabilities on the STM sample mount. Current progress and research plans will be discussed.

¹ This work is supported in part by the Office of Naval Research and Korea Research Foundation.

NS-TuP19 High Selectivity Detection of Trace Explosives using Piezoresistive Microcantilevers, A.R. Krause, University of Tennessee, Oak Ridge National Laboratory, D. Yi, T.G. Thundat, Oak Ridge National Laboratory

Microcantilever arrays offer a miniature, cost effective, and real-time sensor platform for trace explosive detection for combating the terrorist threat. Selectivity in detection in microcantilever arrays is achieved by using receptor layers immobilized on the cantilever surfaces. Despite their high sensitivity and the ability for array-based detection of multiple analytes in real-time, cantilever-based sensor platforms exhibit poor selectivity due to the lack of highly selective receptor layers. Selectivity based on array-based detection and pattern recognition often fails due to the lack of orthogonality in sensor array responses due to the limited number of interactions forming a basis for receptor-analyte interactions. We have developed a receptor-free detection method that can provide high selectivity in explosive vapor detection. In this method adsorbed explosives molecules are allowed to undergo chemical reactions with locally generated ozone to provide an analyte specific cantilever response. The explosive molecules from a vapor generator calibrated with GC-mass spectrometer were first allowed to condense on the cantilever surface. The adsorbed molecules were then exposed to ozone created by a miniature UV lamp for a short period of time and the cantilever responses were recorded as a function of exposure time. We have used a piezoresistive cantilever array in common mode rejection to achieve high selectivity and sensitivity. Recent results for selective and sensitive detection of TNT, RDX, and PETN using this method will be presented.

NS-TuP20 Reactions of Atomic Oxygen on Nanoporous Gold Sponges, A. Wittstock, University Bremen, Germany, J. Biener, M. Biener, Lawrence Livermore National Laboratory, D. Kramer, J. Weissmueller, Forschungszentrum Karlsruhe, Germany, M. Baeumer, V. Zielasek, University Bremen, Germany

In recent years there has been a rising interest in nanoporous gold sponges due to their promising features in low temperature heterogeneous catalysis. Preparation by selectively leaching silver from a gold-silver alloy with acid or a combination of applied voltage and acid leads to a sponge-like morphology with structures in the range of only a few nanometers. Model studies on Au(111) single crystals show a strong interaction of atomic oxygen with the gold surface.¹ The chemisorbed oxygen extracts Au atoms from the surface leading to gold-oxygen complexes on top of it. Inspired by this work we treat nanoporous gold-sponges with atomic oxygen under an ozone-containing ambient atmosphere. We show that in contrast to molecular oxygen the atomic oxygen reacts strongly with the surface leading to a macroscopically detectable shrinking. Measurement of shrinking depending on the concentration of ozone is carried out with a dilatometer. We detect a change of length of nearly 0.5 % of the edge size. The process was accompanied by a black staining which affirms that the oxygen reacts with gold and leads to the formation of gold oxide clusters in the range of a few nanometers on top of the surface. Staining and shrinking can be changed reversibly by reduction with carbon monoxide. In catalytic measurements it is shown that the surface oxygen produced by ozone reacts immediately with carbon monoxide leading to the product of oxidation, the carbon dioxide. These results provide fundamental insight into the allocation of reactive oxygen on catalytically active gold surfaces, the key step of the oxidation reaction on gold catalysts. Furthermore, ozone detection is of great interest in the context of environmental monitoring. Our experiments show that application of gold sponges as chemical gas sensors for determination of ozone is an interesting and promising possibility.

¹ Min, BK; Alemezafar, AR; Biener, MM; Biener, J.; Friend, CM, *Top. Catal.*, 2005, 36, 77.

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Cherkova, S.G.: NS-TuP13, 3
Choi, J.: NS-TuP17, **3**
Choi, Y.J.: NS-TuP7, 2
Crain, J.N.: NS-TuP18, 3

— D —

Dadap, J.: NS-TuP5, 1
Delplancke-Ogletree, M.P.: NS-TuP16, **3**
Demoisson, F.: NS-TuP2, **1**

— E —

Evoy, S.: NS-TuP14, 3

— G —

Goto, M.: NS-TuP3, 1
Gunnarsson, A.: NS-TuP8, **2**

— H —

Ha, J.S.: NS-TuP15, 3
Hiramatsu, T.: NS-TuP11, 2; NS-TuP12, 3
Höök, F.: NS-TuP8, 2
Hozumi, A.: NS-TuP10, **2**

— I —

Ishii, A.: NS-TuP11, 2

— J —

Jeong, B.-Y.: NS-TuP9, **2**
Jeong, G.E.: NS-TuP15, 3
Ji, H.J.: NS-TuP15, 3
Johnson, P.: NS-TuP5, 1
Jönsson, P.: NS-TuP8, 2

— K —

Kachurin, G.A.: NS-TuP13, 3
Kahng, S.-J.: NS-TuP15, 3
Kang, C.J.: NS-TuP7, 2
Kasahara, A.: NS-TuP3, 1
Kato, H.: NS-TuP11, 2; NS-TuP12, 3
Khara, G.S.: NS-TuP17, 3
Kim, G.T.: NS-TuP15, 3
Kim, H.J.: NS-TuP4, 1
Kim, J.-S.: NS-TuP4, 1; NS-TuP9, 2
Kim, J.W.: NS-TuP7, 2
Kim, K.S.: NS-TuP1, 1
Kim, N.H.: NS-TuP1, 1; NS-TuP4, 1; NS-TuP6, 1;
NS-TuP9, 2
Kim, Y.S.: NS-TuP7, 2
Kimura, S.: NS-TuP12, 3
Knox, K.: NS-TuP5, 1
Koo, S.H.: NS-TuP7, 2
Kramer, D.: NS-TuP20, 4
Krause, A.R.: NS-TuP19, **4**

— L —

Lee, B.K.: NS-TuP1, **1**
Lee, J.H.: NS-TuP1, 1
Lim, J.-H.: NS-TuP15, 3

— M —

Marie, R.: NS-TuP8, 2
Marin, D.V.: NS-TuP13, 3
Massart, T.J.: NS-TuP16, 3
Murray, A.J.: NS-TuP14, **3**

— N —

Nakano, R.: NS-TuP12, 3
Nanba, N.: NS-TuP11, 2; NS-TuP12, 3
Nishikawa, O.: NS-TuP11, 2

— O —

Okumura, D.: NS-TuP12, 3
Osgood, R.M.: NS-TuP5, 1

— P —

Park, J.-W.: NS-TuP9, 2
Pihosh, Y.: NS-TuP3, **1**

Potapenko, D.V.: NS-TuP5, 1

— R —

Raes, M.: NS-TuP2, 1
Reniers, F.: NS-TuP2, 1
Roh, Y.H.: NS-TuP1, 1; NS-TuP4, 1; NS-TuP6, 1;
NS-TuP9, 2

— S —

Saito, T.: NS-TuP10, 2
Song, Y.J.: NS-TuP18, **3**
Stroscio, J.A.: NS-TuP18, 3
Stuchinsky, V.A.: NS-TuP13, **3**
Sugiyama, T.: NS-TuP11, 2; NS-TuP12, 3

— T —

Takarai, Y.: NS-TuP11, 2
Takemura, S.: NS-TuP11, 2; NS-TuP12, 3
Tam, E.: NS-TuP16, 3
Taniguchi, M.: NS-TuP11, 2
Taoda, H.: NS-TuP10, 2
Tegenfeldt, J.: NS-TuP8, 2
Thundat, T.G.: NS-TuP19, 4
Tosa, M.: NS-TuP3, 1

— V —

Valla, T.: NS-TuP5, 1
Vereecken, J.: NS-TuP2, 1

— W —

Wang, S.: NS-TuP5, 1
Watanabe, Y.: NS-TuP11, 2; NS-TuP12, 3
Weissmueller, J.: NS-TuP20, 4
Wittstock, A.: NS-TuP20, **4**

— Y —

Yi, D.: NS-TuP19, 4
Yilmaz, M.: NS-TuP5, **1**
Yoo, J.W.: NS-TuP7, 2

— Z —

Zaki, N.: NS-TuP5, 1
Zielasek, V.: NS-TuP20, 4