

Tuesday Afternoon Poster Sessions

Nanometer-scale Science and Technology

Room: Hall D - Session NS-TuP

Poster Session

NS-TuP1 Kinetic Control of Self-catalyzed Indium Phosphide Nanostructures, *R.L. Woo, L. Gao, S. Kodambaka*, University of California, Los Angeles, *N. Goel, M.K. Hudait*, Intel Corporation, *K.L. Wang, R.F. Hicks*, University of California, Los Angeles

Nanowire research has gained tremendous momentum due to its potential applications in nano-electronics, photonics, solar cells, and thermoelectrics. Precise control of size, morphology, density, and uniformity is essential for realizing these commercial opportunities. Most indium phosphide nanowire research is prepared by vapor-liquid-solid (VLS) growth using gold catalysts. However, gold incorporation into the InP is unavoidable and can adversely affect optoelectronic properties. As an alternative, we have investigated the self-catalyzed growth of InP using liquid indium droplets in a metalorganic vapor-phase epitaxy (MOVPE) process. In this study, three distinct shapes were obtained depending on the growth conditions: nanowires, cones, and pillars. The shape of nanostructures is determined by the relative rates of indium phosphide deposition via vapor-liquid-solid and vapor-phase epitaxial growth processes. At the meeting, we will discuss more details on the underlying mechanisms of the crystal growth process and the relationship between the deposition mechanism and the resultant shape of the nanostructure.

NS-TuP2 Polymer Transfer Printing for Chemical Patterns and its Application on Colloidal Assembly, *Y.H. Kim*, Furukawa Electric Co. Ltd., Japan, *B.S. Kim, P.T. Hammond*, Massachusetts Institute of Technology

A new approach to directly organize colloidal particles into patterned arrays using templates coated with a layer-by-layer assembled polyelectrolyte multilayer was introduced. In this approach, a template using a UV-curable photo polymer was coated with polyelectrolyte multilayers, followed by a contact printing of an oppositely charged polyelectrolyte monolayer. The resultant topological template with both positive and negative charges provided a finely defined chemical nano-pattern to guide selective deposition of colloidal particles onto the patterned surface upon Coulombic attraction. For example, when negatively charged dilute colloidal suspensions were placed on the template, the particles were selectively adsorbed within positively charged grooves or holes. Additionally, we have demonstrated development of uniform PEG copolymer chemical patterns via polymer transfer printing and their applications on direct assembly of two different sets of particles to different surface regions. This effective method provides a flexible and versatile route to the development of composite colloidal structures which will present interesting technological applications in photonics, electronics and sensors.

NS-TuP3 Low-energy Electron Beam Calcination to Obtain Well-ordered Mesopores in Titanium dioxide Film, *A. Hozumi, H. Taoda*, AIST, Japan

Mesoporous materials fabricated using organic surfactant molecules or block copolymers as structural directing agents has attracted much attention not only catalysts and adsorbents, but also insulating layers, chemical and gas sensors, and optical and electrical devices. In order to fabricate microdevices based on such well-ordered mesoporous materials, the control of morphologies and geometries in nano ~ micrometer scale is one of the key technologies for practical uses. In this study, we report on a facile and rapid template removal method at low temperature to obtain mesoporous titania film without cracking. Our approach demonstrated here, named "low-energy electron beam (LEEB) calcination," is a novel calcination technique based on the decomposition and oxidation of organic fractions such as surfactants or block copolymers by LEEB irradiation under vacuum. Organic templates can rapidly be eliminated from precursor mesocomposite film within 30 min without distorting periodic mesostructure, resulting in the successful conversion to crack-free ordered mesoporous titania film. Our best rate by LEEB calcination is ~14 times faster than the result obtained by photocalcination using 172 nm vacuum UV light.

NS-TuP4 Structural and Morphological Evolution of Gallium Nitride Nanorods Grown by Chemical Beam Epitaxy, *S.-Y. Kuo*, Chang Gung University, Taiwan, *F.-I. Lai*, Yuan-Ze University, Taiwan, *W.-C. Chen, C.-N. Hsiao*, National Applied Research Laboratories, Taiwan

The morphological and structural evolution is presented for GaN grown by chemical beam epitaxy on (0001) Al₂O₃ substrates. Their structural and

optical properties are investigated by x-ray diffraction, scanning and transmission electron microscopy, and temperature-dependent photoluminescence measurements. While increasing the growth temperature and the flow rate of radio-frequency nitrogen radical, the three-dimensional growth mode will be enhanced to form the one-dimensional nanostructures. The high density of well-aligned nanorods with a diameter of 30–50 nm formed uniformly over the entire sapphire substrate. The x-ray diffraction patterns and transmission electron microscopic images indicate that the self-assembled GaN nanorods are a pure single crystal and preferentially oriented in the c-axis direction. In addition, the enhanced Al(LO) intensity of micro-Raman spectrum confirms the formation of strain-free GaN nanorods in consistent with XRD and HRTEM results. Particularly, the "S-shape" behavior observed in the temperature-dependent photoluminescence might be ascribed to the fluctuation in crystallographic defects and composition. Neither catalyst nor template is required in our epitaxial system make this technique feasible to develop nanodevices based on strain-free III-nitride nanorods.

NS-TuP5 Direct Measurements of the Interaction between Pyrene and Graphite in Aqueous Media by Single Molecule Force Spectroscopy: Understanding the pi-pi Interactions, *Z. Wang, Y. Zhang, X. Zhang*, Tsinghua University, China **INVITED**

In this presentation, we have demonstrated the first direct measurement of the interaction between pyrene and a graphite surface at the single molecular level in aqueous media by AFM-based single molecule force spectroscopy (SMFS). As a model system driven by π - π interactions, pyrene derivatives can effectively adsorb onto the surface of carbon nanotubes and graphite particles. For the investigation of the interaction between pyrene and graphite, we have connected a pyrene molecule onto an AFM tip via a poly(ethylene glycol) (PEG) chain. The use of PEG as a flexible spacer provides a means for differentiating the force signals based on the extension length and thereby for avoiding the disturbance of the nonspecific interaction between the AFM tip and substrate. To confirm the single molecular rupture events of pyrene desorbed from graphite, we have employed modified-freely jointed chain model to fit the force curves, and the fitting parameters are in accordance with that of a single PEG chain. Meanwhile, we have analyzed the distribution of the extension of the force peaks, and found that the most probable value is consistent with the PEG contour length. The statistics of the height of the force peaks shows that the strength of interaction between pyrene and graphite is ~55 pN at the loading rate of 4.0 nN/s. To investigate the dynamic behavior of the interaction between pyrene and graphite, we have performed the SMFS experiment with different retraction velocities to obtain the dynamic force spectroscopy. This result indicates that there is no loading rate dependence at the experiment conditions, and implies that our experiments were carried out under a quasi-equilibrium condition. Therefore, the observed rupture force should equal the adhesion force between pyrene and graphite. This research may open a new route to directly study π - π interactions at a single molecular level, leading to understanding of the formation of supramolecular assemblies through π - π interactions.

NS-TuP7 Synthesis and Field Emission Properties of W18O49 Nanorods, *K. Yong, S. Jeon*, POSTECH, Korea

In recent years, the assembly of 1-D nanostructures in the fabrication of transition metal oxides has received increasing attention due to their interesting potential applications. Among these metal oxide nanomaterials, the fabrication of tungsten oxide nanostructures have been intensively studied due to their promising physical and chemical properties. In current study, we report for the first time the synthesis of tungsten oxide nanorods from tungsten-compound material using a simple annealing of the W₂N/Si substrate. W₂N film was deposited on Si(100) substrate by chemical vapor deposition at 450 °C and then heating of the film at 600 ~ 700 °C produces a high density of tungsten oxide nanorods. The morphology, structure, composition and chemical binding states of the prepared nanorods were characterized by SEM, XRD, XPS, EDX and TEM measurements. XRD and TEM analysis showed that the grown nanorods were single-crystalline W₁₈O₄₉. According to XPS analysis, the W₁₈O₄₉ nanorods contained ~62% of W⁶⁺, ~28% of W⁵⁺, and ~10% of W⁴⁺. Field emission measurements showed a low turn-on field of 9.5 V/ μ m for the W₁₈O₄₉ nanorods, indicating that they can be used as potential field emitters.

NS-TuP8 Computational Simulation of Mechanical and Multi-Physics Behaviour of Micro and Nano-Structures. *R. Said*, Simpleware Ltd., UK, *P.G. Young*, University of Exeter, UK, *B. Walker*, Arup, UK, *A. Abdul-Aziz*, NASA Glenn Research Center, *B. Notarberardino*, University of Exeter, UK

Computational simulation is increasingly proving to be a very effective and valuable tool in investigating materials behaviour at the micro and nano-scale level and in assessing its influence on the overall macro-scale properties. Well established computational techniques (based on numerical methods such as the Finite Element Method) can now be used to simulate mechanical, fluid dynamics, thermal or any combined (multi-physics) phenomena at the micro and nano-scale level. Crucial to the success of such a simulation is the ability to represent the 'micro-architecture' accurately and efficiently - which has proved to be a very challenging task so far. This paper will present an innovative image-based mesh generation technique that converts 3D images of micro and nano-structures (as provided by typical Micro/NanoCT scanners) directly into high fidelity computational models. The approach provides a deeper understanding than experimental tests, and achieves more realistic model results than via analytical approaches. Real-life applications will be presented, including the densification analysis of open celled foam, and the characterisation of composite materials. The aims of the paper is to demonstrate the potential of the proposed approach for understanding the nexus between micro-scale architecture and macro-scale properties, and illustrate the ability to simulate topologically complex problems with a high degree of accuracy but in a fraction of the time taken by other approximate methods. The ability to straightforwardly and robustly model the response of complex micro and nano-architectures provides powerful new tools for the material scientist to easily explore the influence of various parameters on the performance of novel complex material systems, which will be increasingly used in addition to and in combination with analytical modelling and experimental tests. These computational techniques will also be pivotal to the development of tools for material characterization of complex composites using inverse modelling techniques.

NS-TuP9 Fabrication of Three-Dimensionally Periodic Macroporous TiO₂ Thin Film for Photovoltaic Application. *S.B. Yoon, Y.H. Kim, K. Kim, B.-C. Woo*, Korea Research Institute of Standards and Science, *S.J. Chung*, Korea Research Institute of Bioscience and Biotechnology, *W.S. Yoon*, Korea Research Institute of Standards and Science

Three-dimensionally (3D) periodic macroporous TiO₂ thin film was fabricated by using polystyrene sulfonate (PSS) nanoparticle as an organic template and titanium alkoxide as a TiO₂ precursor on fluorine-doped tin oxide (FTO) glass. Close-packed colloidal crystalline thin film composed of PSS nanoparticles was prepared by using 2D deposition technique. The TiO₂ precursor was immersed into the void space between PSS nanoparticles and subsequently in-situ hydrolysis and condensation were performed. The nanocomposite of PSS nanoparticles and amorphous TiO₂ was calcined to remove the organic materials and to crystallize the amorphous TiO₂ to anatase type at 450°C under air flowing. Resultant anatase TiO₂ thin film was exhibited the 3D periodic macroporous framework with connecting windows. Photovoltaic cells composed of the Ru-dye coated 3D periodic macroporous anatase TiO₂ thin film were fabricated and their energy conversion efficiency was also investigated.

NS-TuP10 Vapour Phase Deposition of Aromatic Self-Assembled Monolayers. *L. Kankate, H. Muzik, A. Turchanin, A. Götzhäuser*, University of Bielefeld, Germany

Self-assembled monolayers (SAMs) with aromatic moieties recently caused a particular interest due to their applications in molecular electronics,¹ nanolithography^{2,3} and biotechnology.⁴ For high quality SAM-based devices and nanostructures, a reproducible fabrication of high quality SAMs is necessary. The traditional "wet" preparation of SAMs may suffer from solvent, ambient and substrate contaminations resulting in poor quality and degradation of the molecular assemblies. On the contrary, the preparation of SAMs in UHV can provide a high degree of control over the experimental parameters. We have studied the formation of 1,1'-biphenyl-4-thiol (BPT) and 4'-nitro-1,1'-biphenyl-4-thiol (NBPT) SAMs on gold surfaces by vapour deposition in UHV. The vapour deposited monolayers were characterized by mass spectrometry, X-ray photoelectron spectroscopy (XPS) and scanning tunnelling microscopy (STM). Based on this data, the deposition parameters were optimized. A comparison of vapor deposited SAMs with monolayers prepared from solution is presented.

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⁴A. Turchanin, A. Tinazli, M. El-Desawy, H. Großmann, M. Schnietz, H.H. Solak, R. Tampé, A. Götzhäuser, Adv. Mater. 20 (2008) 471.

NS-TuP11 Characteristics of La-substituted Bismuth Titanate Ferroelectric Nanofibers by Electrospinning. *K.T. Kim*, University at Buffalo, the State University of New York, *C.I. Kim*, Chung-Ang University, Korea, *Y.K. Yoon*, University at Buffalo, the State University of New York

The bismuth layer-structured ferroelectrics have been known as high dielectric materials with attractive properties such as environmentally friendly lead-free composition and fatigue free characteristic. Specially, the La-substituted Bismuth Titanate (Bi_{1.25}La_{0.75}Ti₃O₁₂:BLT) has received the intensive attention for their excellent ferroelectric, crystalline properties as a promising dielectric for capacitors and memory devices.¹ Recently, there has been an intense research effort on one dimensional nano materials such as nanotube and nanofiber due to their unique structure and properties, such as high aspect ratio, large specific surface area and chemical/mechanical stabilities.² In this study, BLT nanofiber synthesis has been demonstrated using electrospinning and subsequent sintering. A composite solution consisting of a metal-organic decomposition solution of BLT and a binder of poly(vinylpyrrolidone) (PVP) has been electrospun in an electric field of 3 x 10⁵ V/m to form nanofiber with a diameter of 120 nm. The BLT/PVP composite nanofiber has been calcined in air for 1 h at 500, 600, 700, 750, and 800 °C, respectively. The characteristics by X-ray diffraction, FT-IR, SEM and HR-TEM of the BLT/PVP composite nanofibers are reported.

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NS-TuP12 Nanostructured Glassy Carbon Supported GC/Pt Electrodes for Model Studies of Fuel Cell Relevant Electrocatalytic Reactions. *Y.E. Seidel, A. Schneider, L. Colmenares, Z. Jusys, R.J. Behm*, Ulm University, Germany, *B. Wickmann, B. Kasemo*, Chalmers University of Technology, Sweden

In this contribution, we discuss the potential of nanostructured planar electrodes for model studies of electrocatalytic reactions relevant for Polymer Electrolyte Fuel Cell (PEFCs). The model electrodes consist of catalytically active Pt nanostructures of well-defined size and separation, which are supported on planar glassy carbon substrates.^{1,2} They are fabricated employing colloidal lithography (CL)¹ or Hole-mask Colloidal Lithography (HCL),² or by micellar techniques, via deposition of metal loaded micelles and the subsequent removal of the polymer stabilizer.³ Both techniques allow us to independently vary size and separation of the catalytically active nanostructures/particles. The resulting particle sizes are ca. 3-15 nm (micellar techniques) and 70-150 nm (CL, HCL), respectively. These nanostructured model electrodes allow direct and quantitative access to an important aspect of electrocatalytic reactions which so far has been largely neglected, to the influence of mesoscopic transport effects on the characteristics of electrocatalytic reactions. Using the reduction of O₂ and the oxidation of formaldehyde as examples it will be shown that mass transport effects not only modify the overall rate, but have significant effect also on the product distribution, e.g., on H₂O₂ formation. Possible contributions of the reactant transport to the overall reaction process will be discussed in a molecular picture.

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NS-TuP13 Dimer Ordering of M-TtertBuPc on Graphite. *T. Takami, C. Carrizales, K.W. Hipps*, Washington State University

The growth and ordering of metal complexes of 2,9,16,23-tetra-tert-butylphthalocyanines (TtertBuPc) on graphite surface have been studied by scanning tunneling microscopy. A well-ordered molecular layer having the molecular plane lying parallel to the graphite substrate was obtained at the solution - graphite interface at room temperature. For Cu-TtertBuPc, dimer ordering similar to that reported previously on the Si(111)-r3Xr3-Ag surface¹ was partly observed. We will also discuss the effects of changing the center metal and/or the phthalocyanine to naphthalocyanine, and imaging and orbital mediated tunneling spectroscopy in ultrahigh vacuum (UHV).

¹ S. A. Krasnikov et al., J. Phys. Condens. Matter 19 (2007) 446005.

NS-TuP14 Optical Performance of EUV Lithography Mask with Silver Doped Zinc Oxide Absorber. *H.Y. Kang, M.K. Kim, C.K. Hwangbo*, Inha University, Republic of Korea

The lithography performance of extreme ultraviolet lithography (EUVL) mask depends on the correct choice of absorber materials because it is directly related to imaging contrast, shadowing effect, focus shift effect, and thermal effect.¹ The optical constant of the absorber materials in the EUV region should have higher extinction coefficient for higher attenuation. Also, the absorber material should exhibit good conductivity, which can

alleviate the charging effect during electron-beam patterning. In the past, a wide range of materials (Ti, TiN, Al-Cu, TaSi, Ta, TaN, Cr, etc) has been evaluated as possible conductive absorbing materials for EUVL mask.^{2,3} The total thickness of the absorber stack by using the materials used to be greater than 80 nm because the available absorbing materials are limited and an anti-reflection coating is necessary to maximize pattern inspection efficiency at deep ultraviolet wavelength. It is reported that the large thickness of the absorber stack may cause a geometric shadow effect in an exposure step and as a result, the printed patterns are shifted and biased.⁴ In this study, we propose a new absorber stack with a silver doped zinc oxide absorber layer. The optical constants of ZnO layers with various concentration of Ag at 13.5 nm are calculated. It is found that the optical constants of ZnO layers with high concentration of Ag show lower refractive index and higher extinction coefficient at 13.5 nm than those of TaN layer. Thus ZnO layers doped with Ag enables EUVL masks to be designed to have very small height difference between high reflecting and absorbing stacks, suggesting that the geometric shadow effect can be significantly reduced.

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NS-TuP15 Actinide Powder Characterization for Nuclear Forensics, W.S. Duncan, A.D. Neuman, C.C. Davis, T.A. Nothwang, Los Alamos National Laboratory

Half of the Department of Energy's nuclear forensics scientists are expected to retire within the next 15 years but there continue to be around 10 confirmed cases of nuclear material trafficking each year.^{1,2} The Interfacial Science team of LANL's Materials Science & Technology division is addressing this need for new nuclear forensics expertise by helping to create a database of actinide powder characteristics. This poster addresses physical characterization on a nanoscale level via microscopy and other methods in order to obtain microstructural and elemental composition as well as crystal structure of known powders.

¹ Mayer, K., et al., CSI: Karlsruhe. Actinide Research Quarterly, 2007. 4th quarter: p. 1-9.

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NS-TuP16 Template-Free Synthesis and Characterization of Copper Oxide Nanostructures, K.-R. Lo, C.-C. Chang, National Taiwan University

As a relatively non-toxic p-type semiconductor and a classical example of excitonic solid, cuprous oxide may play an important role in the electronics industry as the dimensions of electronic devices continue to shrink. For example, devices made of nanometer-scale cuprous oxide are expected to be small and fast because the electrical signal can resonantly tunnel through the nanoscale cuprous oxide layers. In addition, cuprous oxide structures fabricated in the nanoscale may exhibit better antifouling and algicide effects, increase its overall water splitting capability for solar energy applications, and enhance its photocatalytic activity for degradation of organic pollutants under visible light. Nanoscale cuprous oxide structures were prepared in this study via a template-free synthetic approach in the ethylene glycol solution using different copper compounds as the precursor. SEM images and Auger spectra revealed that, instead of forming spherical particles, micro- to nano-sized aggregates of well-defined geometric shapes were obtained. These aggregates were made of nanocrystalline particles, as revealed in high-resolution TEM and diffraction studies, which self-assembled into organized solids. XPS spectra suggested that the crystallization and the self-assembling may take place via cuprophilic attraction. The shape and the dimensionality of the assemblage obtained can be controlled by adjusting reaction temperature and/or by using different surfactants. Chemical conversion of cuprous oxide to cupric oxide impaired the cuprophilic interaction, leading to dismantling of the assemblage at extended reaction time. The chemical process and the mechanism involved in the assembling and dismantling of the polycrystalline assemblage will be discussed.

NS-TuP17 Preferred Diameter Growth of Single-Walled Carbon Nanotube by using Sapphire Substrates, K.-Y. Shin, National Tsing Hua University, Taiwan, J.-S. Kao, National Applied Research Laboratories, Taiwan, K.-C. Leou, C.-H. Tsai, National Tsing Hua University, Taiwan

Single-walled carbon nanotube (SWCNT) has been considered as an alternative material for nano-devices, such as carbon nanotube field-effect-transistor or nano-sensor. It has been found that the characteristics of the SWCNT-based device are affected by the band gap of the tube, which depends on its diameter and chirality. Preferred diameter growth of single-walled carbon nanotube (SWCNT) by using single crystal sapphire (0001) and sapphire (110-2) substrates is reported. The carbon nanotubes were

grown by mono-layered iron catalyst from sapphire substrate and a mixture of methane and hydrogen at 900°C by chemical vapor deposition. Atomic force microscopy revealed that the particle size distribution of catalyst was varied with different orientation sapphire substrate. The micro-Raman spectra exhibited that the radial-breathing mode signals of SWCNTs grown by Fe (1nm) catalyst were shifted with different orientation sapphire substrates. A growth model based on minimum strain theory (i.e. O-lattice theory) and surface tension theory is proposed.

NS-TuP18 Green Synthesis and Mechanism of ZnSe Nanoflowers, Q. Dai, Worcester Polytechnic Institute, N. Xiao, B. Zou, Jilin University, China, W. Yu, Worcester Polytechnic Institute

We introduce a nontoxic, simple, cheap and reproducible strategy, which meets the standard of green chemistry, for the synthesis of ZnSe nanoflowers. These green nanomaterials with a zinc blende structure can be readily scaled up and produced directly at ambient condition without affecting their qualities. A systematic study of the nanoflower formation process indicates the recently reported "limited ligand protection" mechanism cannot be employed to explain the formation of our nanoflowers. Instead, a new growth mechanism is proposed: Upon heating at high temperature, mononuclear Zn complexes convert to polynuclear Zn complexes with multiple Zn atoms. Each Zn atom grows into one ZnSe nanoparticle after the injection of Se solution. These nanoparticles closely connect and thus look like nanoflowers.

NS-TuP19 Fabrication of Porous Si Using Anodic Aluminum Oxide, N.Y. Kwon, K.H. Kim, J.M. Kwon, I.S. Chung, Sungkyunkwan University, Korea

Porous Si templates with various pore patterns were obtained by etching underlying Si using an anodic aluminum oxide (AAO) mask. Si₃N₄ imprint stamps with a nano size matrix pillar (height : 50 nm) pattern were indented into Al film grown on Si wafer using an oil press method with the force of 5kN·cm⁻². After indenting on Al thin film (thickness : 200 nm), we found that the periodic array with 30 nm depth was formed on Al thin film using scanning probe microscopy. The indented Al film was then anodized using two different anodizing conditions, namely, 0.3M oxalic acid of 4°C at 50V and 0.3M sulfuric acid of 10°C at 25V, and these conditions were suitable to define the matrix pore pattern. As pore's size and interval were decided by anodizing conditions, pre-patterning must set to anodizing condition to get regular pattern. We can control the size of pore and the interval of pore by modifying the aforementioned anodizing conditions. Thus, we can achieve a well organized Si porous template by transferring AAO pattern using ICP etcher with 30 W of rf power, 30 mTorr total pressure, 30 SCCM of CF₄, and 4 SCCM of O₂.

NS-TuP20 Fabrication and Characterization of One-Dimensional Semiconducting Nanowire That Use AAO, K.H. Kim, N.Y. Kwon, J.K. Hong, I.S. Chung, Sungkyunkwan University, Korea

In this study, we attempted to fabricate and characterize one dimensional semiconducting nanowire (CdSe, Polypyrrole). It is well known that CdSe is n-type material, whereas polypyrrole is p-type material. The template used in the nanowire growth was AAO (Anodic Aluminum Oxide) template. After forming AAO template on Al foil, the oxidized underlying barrier layer was removed using a cathodic polarization method based on KCl(0.5mol, -5V, 4°C) solution. Then, nanowires with 50nm diameter and 300nm height were grown using the electroplating method. Finally, the nanowires were characterized using SPM (Seiko Instruments, SPA 300HV) by proving the conductive cantilever. I-V characteristics as a function of the temperature gives an activation energy which is useful to understand the conduction mechanism of semiconducting nanowires.

NS-TuP21 Nanofabrication by Near-Field Photochemical Modification of Phosphonic Acid Monolayers on Titanium Dioxide, G. Tizazu, G. Leggett, D.G. Lidzey, University of Sheffield, UK

Phosphonic acid self assembled monolayers were formed on titanium oxide surfaces. Exposure of the samples to a UV light of wave length 244nm through a mask resulted in photo degradation of the monolayers in exposed areas leaving undegraded molecules in unexposed areas. Titanium oxide microstructures were produced by immersing the photo patterned samples in to a KOH solution. The phosphonic acid monolayers exhibited a surprising "switchable" character, performing as positive tone resists at low UV exposures but behaving as negative tone resists at high exposures. Backfilling the photo-degraded monolayers with a second phosphonic acid molecule with a different end group (for example an amine terminated adsorbate) yielded patterns consisting of regions with different chemical compositions. Aldehyde and amine modified fluorescent nanoparticles were attached to the chemically patterned surfaces, demonstrating their potential for fabricating complex functional architectures. Nanometre scale structures

were produced by utilising a scanning near-field optical microscope (SNOM as the light source).

NS-TuP22 Nanopatterning by Near-Field Photodeprotection of 2-Nitrophenylpropyloxycarbonyl-Protected Aminosiloxane Monolayers on Glass. *S. Alang Ahmad*, University of Sheffield, UK, *L.-S. Wong*, University of Manchester, UK, *E. Haq, J. Hobbs, G. Leggett*, University of Sheffield, UK, *J. Micklefield*, University of Manchester, UK

Nanometre scale control of chemical reactivity is key for many applications of nanotechnology in biology, electronics, materials science, etc. Currently there are few methods for the selective initiation of chemical transformations with nanometre precision. Here we report a novel approach to nanopatterning in which a scanning near-field optical microscope coupled to a near-UV laser is used to selectively deprotect 2-nitrophenylpropyloxycarbonyl (NPPOC) protected aminosiloxane monolayers on glass. Initially, UV deprotection was studied for unpatterned samples using X-ray photoelectron spectroscopy and contact angle measurements. The resulting amine-terminated surfaces were activated with glutaraldehyde and then derivatized using a fluorinated adsorbate and aldehyde polymer nanoparticles. Contact angle and XPS measurements indicate extensive surface functionalisation. Next, micrometre-scale patterns were fabricated using mask-based exposure to light from a He-Cd (325 nm) or Ar-ion (364 nm) laser, and characterised by friction force microscopy. Nanoparticle patterns were formed by covalent attachment methods. Nanometre scale patterns were fabricated using near-field exposure, and characterised by FFM. The nanopatterns were derivatised with functionalised molecules, showing that high spatial resolution (ca 100 nm) was readily achievable, and also that extensive functionalisation of the patterns could also be accomplished.

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Kwon, N.Y.: NS-TuP19, 3; NS-TuP20, 3

— L —

Lai, F.-I.: NS-TuP4, 1
Leggett, G.: NS-TuP21, 3; NS-TuP22, 4
Leou, K.-C.: NS-TuP17, 3
Lidzey, D.G.: NS-TuP21, 3
Lo, K.-R.: NS-TuP16, 3

— M —

Micklefield, J.: NS-TuP22, 4
Muzik, H.: NS-TuP10, 2

— N —

Neuman, A.D.: NS-TuP15, 3
Notarberardino, B.: NS-TuP8, 2
Nothwang, T.A.: NS-TuP15, 3

— S —

Said, R.: NS-TuP8, **2**
Schneider, A.: NS-TuP12, 2
Seidel, Y.E.: NS-TuP12, **2**
Shin, K.-Y.: NS-TuP17, 3

— T —

Takami, T.: NS-TuP13, **2**
Taoda, H.: NS-TuP3, 1
Tizazu, G.: NS-TuP21, **3**
Tsai, C.-H.: NS-TuP17, 3
Turchanin, A.: NS-TuP10, 2

— W —

Walker, B.: NS-TuP8, 2
Wang, K.L.: NS-TuP1, 1
Wang, Z.: NS-TuP5, **1**
Wickmann, B.: NS-TuP12, 2
Wong, L.-S.: NS-TuP22, 4
Woo, B.-C.: NS-TuP9, 2
Woo, R.L.: NS-TuP1, **1**

— X —

Xiao, N.: NS-TuP18, 3

— Y —

Yong, K.: NS-TuP7, 1
Yoon, S.B.: NS-TuP9, 2
Yoon, Y.K.: NS-TuP11, 2
Young, P.G.: NS-TuP8, 2
Yu, W.: NS-TuP18, 3
Yun, W.S.: NS-TuP9, 2

— Z —

Zhang, X.: NS-TuP5, 1
Zhang, Y.: NS-TuP5, 1
Zou, B.: NS-TuP18, 3