Thursday Afternoon Poster Sessions

Applied Surface Science

Room: 4C - Session AS-ThP

Aspects of Applied Surface Science II Poster Session

AS-ThP1 DNA Microarrays to Detect the Serotype of Dengue Viruses in a Large Number of Samples from Mosquitoes or Patients Collected in Mexico , *A. Diaz-Badillo,* CINVESTAV-IPN, Mexico, ***V. Altuzar***, Universidad Veracruzana, Mexico, *J.G. Mendoza-Alvarez*, CINVESTAV-IPN, Mexico, *A. Cisneros,* Universidad Autonoma Benito Juarez, Mexico, *F. Jimenez-Rojas, J.P. Martinez-Muñoz,* Salud Pública y Servicios de Salud de Oaxaca, Mexico, *J.L. Herrera-Perez,* CICATA-IPN, Mexico, *C.O. Mendoza-Barrera,* Universidad Veracruzana, Mexico, *F. Sanchez-Sinencio, P. Gariglio-Vidal, M.L. Muñoz,* CINVESTAV-IPN, Mexico

Dengue is a mosquito-borne viral infection causing a major public health problem globally. Dengue virus (DENV) is the causative agent of dengue fever and dengue hemorrhagic fever and includes four distinct serotypes (DEN-1, DEN-2, DEN-3, and DEN-4). DEN-2 and DEN-3 have been associated with severe dengue disease. In this work we demonstrated a high throughput of microarrays for detection of dengue virus in serum samples from patients with a defined dengue infection from Oaxaca or in mosquito population collected across eighteen Mexican states. We have applied microarray analysis for simultaneous serotyping multiple RNA samples from human or mosquitoes through the NS3 genome. The proposed microarray method can be used for i) rapid and reliable dengue diagnosis; ii) serotyping and iii) surveillance of mosquitoes infected with dengue. Moreover by using these microarrays we have determined DEN viruses in pools of gravid females mosquitoes collected in several sites of eighteen Mexican states in 2005. Our microarrays were also useful to confirm the presence of DEN-2 in 96 serum samples, DEN-3 in three samples from Oaxaca city and one case from Juchitán, Oaxaca contained DEN-2 and -3. The microarrays quantification were validated by using RT-PCR, in fact they presented agreement in all cases excepting with those mosquito samples collected in one site of Chiapas, Oaxaca, Morelos and Nayarit. In conclusion, we show the success of applying microarrays assay to provide a consistently robust qualitative detection of dengue serotypes (DEN-1, DEN-2, DEN-3 and DEN-4) in serum samples from patients or in pools of gravid female mosquitoes collected in the field of eighteen Mexican states.

AS-ThP2 Surface Engineering with Functional Soft Materials, ***M. Yan***, Portland State University

Organic and polymeric materials are effective in tailoring the chemical and physical properties of the surface layer, and to introduce functions to materials. We have developed a simple and versatile method for attaching a wide range of soft materials on solid substrates. The technique employs a photochemical coupling chemistry that is fast, efficient, and is capable of creating structures with control over density and topography.[1] Applications of this surface functionalization technique for the fabrication of nanowells,[2] carbohydrate microarrays[3] and single polymers[4] will be highlighted.

[1]Liu, L.; Engelhard, M. H.; Yan, M. "Surface and Interface Control on Photochemically Initiated Immobilization", J. Am. Chem. Soc. 2006, 128, 14067-14072.

[2]Yan, M.; Bartlett, M. "Micro/Nanowell Arrays Fabricated from Covalently Immobilized Polymer Thin Films on a Flat Substrate," Nano Lett. 2002, 2, 275-278.

[3]Pei, Z.; Yu, H.; Theurer, M.; Walden, A.; Nilsson, P.; Yan, M.; Ramström, O. "Photogenerated Carbohydrate Microarrays", ChemBioChem 2007, 8, 166-168.

[4]Liu, L.; Yan, M. "A General Method for the Covalent Immobilization of Single Polymers," Angew. Chem. Int. Ed. 2006, 45 (37), 6207-6210.

AS-ThP4 A Quantitative Model Relating Interphase Chemistry and Adhesive Fracture in Steel Cord-Rubber Composites, ***G.E. Hammer***, The Goodyear Tire & Rubber Company

In steel cord-rubber adhesion testing high rubber coverage, or cohesive fracture in the rubber, is generally accepted as a necessary condition for good adhesive bonding. On the microscopic level the transition from high rubber coverage to exposed wire is a transition from fracture in the rubber to separation in the sulfide layer in the adhesive interphase. This sulfide layer is a mixture of copper(I)- and zinc sulfides. Multivariate statistical analysis of Auger depth profiles of the interphase produced chemical depth profiles from which the composition of the interfacial sulfide (percent zinc sulfide and copper(I)sulfide) can be measured. For a variety of compounds, cures, and aging conditions the rubber coverage was a function of the percent zinc sulfide, with rubber coverage dropping abruptly as the percent zinc sulfide increased from 60 to 80%; specifically the a rubber coverage of one-half the initial value appeared to correspond to a percent zinc sulfide of 75%. A mechanism has been proposed wherein the loss of adhesion was attributed to the one or both of (i) overgrowth of the bonding copper sulfide by the non-bonding zinc sulfide in the interphase, (ii) embrittlement of the sulfide by increased content of zinc sulfide.

AS-ThP5 Electronic States of Fe Atomic Chains on Pt (997) Surface, ***R. Cheng***, *E. Ayieta,* Indiana University-Purdue University, *Y. Losovyi*, Louisiana State University

The study of low dimensional systems is of great interests due to their technical applications as well as the rich fundamental physics. The variety of one dimensional atomic chains can be synthesized on stepped surfaces, which provide opportunities for systematically tailoring the surface properties. The electronic structure of the high vicinal surface plays an essential role to determine the physical properties of the atomic chains as well as the surface catalysis. We have used several surface analysis techniques to study the surface of the (997) single crystal. The scanning tunneling microscopy and low energy electron diffraction results show that the surface has uniform step terrace without any reconstruction. The angle resolved ultra violet photoemission spectroscopy was performed to characterize the band structure of Pt(997) surface by using synchrotron radiation source. Then Fe were carefully deposited on to Pt(997) substrate at room temperature. The atomic resolution STM data shows that Fe atomic chains were formed along the step edges due to the step decoration. Finally angle resolved ultra violet photoemission spectroscopy was also performed to characterize the Fe atomic chains.

AS-ThP6 Using a Dual-Beam SIMS to Study Nano-scale Metallic Thin Films and Biological Samples, ***H. Chen***, *T. Bunai, E.R. Tracy, W.E. Cooke, A.L. Wilkerson*, College of William and Mary, *S. Rossnagel,* IBM T.J. Watson Research Center, *D. Manos*, College of William and Mary

Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) offers high sensitivity and mass resolution. It is used widely in both research laboratories and industry. While TOF-SIMS is a well established surface analyzing method, high resolution depth-profile analysis is often desired in semiconductor industry, nano-structure manufacturing and engineering. Using a TRIFT II dual-gun system, which is equipped with a Au_n^+ gun as primary beam and an Argon gun as sputter beam, we studied a series of samples that consist of multilayer, nano-scale metallic thin films. Depth profiling is carried at different sputter energies (500eV-5keV) and the resolution is compared for these different sputter energies. Using the imaging capability of TOF-SIMS, the image of the crater after sputtering is obtained and the ion mixing at interface is studied. The result is compared with TRIM simulations. One great advantage that TOF-SIMS offers over other types of mass spectroscopy like MALDI is sub-micron spatial resolution. MALDI is the primary method used in mass spectroscopic imaging of biological samples like cells and tissue sections. Though MALDI offers a wide mass range, the spatial resolution, limited by the matrix crystal size and laser beam spot size, is often tens of microns. SIMS high spatial image is a well suited complement to MALDI image. The argon sputtering, though primarily used to study inorganic samples, was recently used to expose cell inner structures for electron microscopy images. Using the dual-beam system, we studied a prostate tissue section. The sputtering rate is determined, and depth-profiles are correlated to interior cell structures in the SIMS image.

AS-ThP7 Characterization of Mobile Ions in Insulating Materials and Their Effect on Polymer Adhesion, ***K.M. Stika***, DuPont, *K. Proost, A. De Backer,* DuPont-Belgium, *J.R. Marsh, D.E. Davidson, D.G. Swartzfager, K.G. Lloyd*, DuPont

Adhesion of polymers to inorganic substrates can be seriously affected by the surface and interfacial chemistry of the adjoining layers. Modification of the substrate through heating, chemical treatment, accelerated aging or environmental exposure has been shown to contribute to the ultimate adhesion performance of laminate and multilayer structures. Similarly, diffusion of ions from a glass surface with the formation of a leached ion layer under varied conditions is also a well known phenomenon. It follows that the ability to control and profile elemental composition and depth distribution of highly mobile ions in the near surface region of inorganic materials is an important tool for the fundamental understanding of polymer/inorganic adhesion. This presentation will highlight recent efforts to profile near surface mobile ions as a function of substrate aging or surface treatment and the correlation of these chemical profiles with changes in polymer/inorganic adhesion performance.

AS-ThP8 Molecular Dynamics Simulations of 30 keV and 2 keV Ga in Si, ***L.A. Giannuzzi***, FEI Company, *B.J. Garrison*, The Pennsylvania State University

Molecular dynamics simulations of 2 keV and 30 keV Ga bombardment of Si(011) at a grazing angle of 88 degrees show that the dynamics effectively follow scattering from a flat surface and that very little energy is transferred to the substrate. The inclusion of an adatom above the surface allows for the coupling of the energy of motion parallel to the surface into the substrate. The adatom and one other Si atom eject and motion in the substrate occurs down to a depth of 13 Å. These results show that some surface roughness is necessary for sputtering to occur at very grazing angles of incidence (i.e., high incident angles). Therefore, it is unlikely that focused ion beam polishing can create a non-facetted or atomically smooth surface.

AS-ThP9 Residual Stress of Focused Ion Beam-Exposed Polycrystalline Silicon, ***K. Archuleta***, University of New Mexico, Sandia National Labs, *D.P. Adams, M.J. Vasile*, Sandia National Labs, *J.E. Fulghum*, University of New Mexico

Focused ion beam systems are increasingly utilized to fabricate tools, instruments, sensors and devices on the micrometer and nanometer scales. It is thus critical to understand the impact of FIB bombardment on the relevant properties of different materials. Despite many investigations of implanted gallium concentrations, surface roughening and microstructural changes, few studies have quantified the residual stress that results from FIB exposure. Medium energy (30 keV) focused gallium ion beam exposure of silicon results in a compressive inplane stress with a magnitude as large as 0.4 GPa. Experiments involve uniform irradiation of thin polysilicon microcantilevers (200 µm in length) over a range of dose from 1 x 10^{16} to 2 x 10^{18} ions/cm^2. The radii of curvature of microcantilevers are measured using white light interferometry in atmosphere before and after ion beam exposure. The residual stress is determined from these radii and other measured properties using Stoney's Equation. The large residual stress is attributed to ion beam damage, microstructural changes and implantation.

AS-ThP10 Nanoindentation Study of Silicon-on-Insulator (SOI) and Strained (sSOI) Multilayers Composite Films, ***J.E. Jakes***, University of Wisconsin-Madison and USDA Forest Products Laboratory, *D.S. Stone*, University of Wisconsin-Madison, *K. Tapily, H. Baumgart*, Old Dominion University, *G. Celler*, SOITEC, Bernier-Grenoble, France, *A.A. Elmustafa*, Old Dominion University

Silicon-on-Insulator (SOI) technology provides an engineered composite substrate where the active top Si device layer is decoupled from the mechanical support wafer by an interspersed electrically insulating and mechanically compliant silicon oxide layer. The main application of SOI technology is found in microelectronics, where SOI offers CMOS performance enhancement with the use of an embedded oxide layer to isolate transistors from the substrate, which results in lower parasitic capacitance and reduced junction leakage and a host of other benefits. For further performance gain lattice strain can be incorporated into SOI films in order to enhance carrier mobility for MOSFETs. Bi-axially tensile strained sSOI films were obtained with a fabrication sequence of epitaxially growing 150 Å to 600 Å strained Si films on a relaxed 20% Ge containing $Si_{1-x}Ge_x$ buffer layer on a donor wafer. During epitaxy the Si lattice stretches to match the larger $Si_{1-x}Ge_x$ lattice. The larger lattice constant of Ge produces a 4.1% lattice mismatch with the Si crystal. The higher the Ge alloy concentration, the higher the embedded strain becomes. Following successful bonding of both wafers, the donor wafer was split off with the Smart Cut™ exfoliation technique. The surface was then finished with an etching process to completely remove all traces of the $Si_{1-x}Ge_x$ film, resulting in a Ge-free bi-axially strained Si film on amorphous SiO_2 insulator. In this work we use nanoindentation to investigate the hardness and modulus of standard relaxed SOI and bi-axially tensile strained sSOI with Si films ranging in thickness from 10 to 60 nm and extreme strained xsSOI multilayer samples. The elastic response of the silicon-oxide-silicon substrate multilayer system to indentation can be modeled using elasticity theory, which reveals excellent agreement with the experimental results. The nanoindentation experiments detect a 5% difference in composite modulus with indent depths between 30 and 40 nm deep for 60 nm-thick tensile strained sSOI films compared to SOI films. These strained films are grown epitaxially on a $Si_{0.80}Ge_{0.20}$ buffer layer followed by wafer bonding and film exfoliation by the Smart Cut™ technology. The sSOI and xsSOI thin films exhibit mean tensile stress levels of 1.3 GPa and 2.5 GPa respectively using a $Si_{0.60}Ge_{0.40}$ buffer layer.

AS-ThP11 Study of Photocatalytic Activity in the Low Temperature-Annealed TiO_2 Thin Film Prepared by Sol-Gel Technique, ***A. Majumder***, *S. Biswas, M.F. Hossain, T. Takahashi*, University of Toyama, Japan, *Y. Kubota*, University of Yokohama City, Japan, *A. Fujishima*, Kanagawa Academy of Science and Technology, Japan

Semiconductor photocatalysts, particularly titanium oxide (TiO_2) with high photocatalytic activity, offers convenient route of purification of air and water and a provision of 'self-maintaining' clean surface. Several physical and chemical techniques have been used to prepare titanium dioxide thin film. Among the various techniques, the relatively simple sol-gel method is the most widely used because of its ability to obtain films with tailored properties on large, curved substrates. However, generally post-deposition annealing at high temperature is required for achieving crystalline phase. Crystallinity is one of the key factors behind the photocatalytic activity of TiO_2, therefore achievement of better crystallinity at relatively low temperature is an important issue. In our present study, the titanium dioxide porous films were deposited on glass slides by sol–gel technique; where, an alcoholic solution of tetra-buthylorthotitane was hydrolysed in a water/alcohol/acetic acid mixture. The solution thus prepared was deposited on glass substrates. These films were transparent and crack free. All the films were annealed at different annealing temperatures, ranging from 350° C to 500°C. Sufficiently good crystalline sample was obtained by annealing at 350° C. For this present investigation; annealing temperature and number of coating layers were varied. The sol was initially characterized by DTA-TGA. The structure and optical characterizations of these films were made by X-ray diffraction and UV-Vis spectroscopy, respectively. XRD patterns of all the titanium dioxide films confirmed the anatase structure. The surface morphology of the films was observed by atomic force microscope (AFM) and scanning electron microscope (SEM). The morphology of porous titanium dioxide thin films strongly depends on annealing temperatures and number of coatings. The photocatalytic activity of the TiO_2 thin films was evaluated by the decomposition of methanol with the help of FTIR spectroscopy. It has been observed that the photocatalytic activity of the TiO_2 thin films increases with the optimization of annealing temperature as well as with the increase of the numbers of layers. The variation of photocatalytic activity with different annealing temperatures and different number of layers is interpreted in terms of different crystallinity, porosity and surface morphology.

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