Applied Surface Science
Room: Exhibit Hall B2 - Session AS-TuP

Topics in Applied Surface Science

AS-TuP1 Observation of Preferably Electrical Activation of Boron Implanted at Low Energy by Scanning Capacitance Microscopy, ***M.-N. Chang***, National Nano Device Laboratories, Taiwan R.O.C., *D.-H. Deng*, National Tsing Hua University, Taiwan R.O.C., *C.-Y. Chen*, National Nano Device Laboratories, Taiwan R.O.C., *J.-H. Liang*, National Tsing Hua University, Taiwan R.O.C., *F.M. Pan*, National Nano Device Laboratories, Taiwan R.O.C.

Ultrashallow doping is one of the technical trends on ultra large-scale integrated circuit. Low energy ion implantation combined with rapid thermal annealing (RTA) is necessary to obtain required ultrashallow doping profiles. It is well known that scanning capacitance microscopy (SCM) is a promising technique providing two-dimensional (2D) doping profiles. In this work, we have provided a new method employing plane view SCM images to investigate the lateral carrier distribution in ultrashallow p$^+$ junctions formed by BF$_2^+$ implantation at low energies. RTA processes were performed at 550, 850 and 1050 °C for different anneal times from 5 to 120 seconds in N$_2$ ambient. The width and pitch of the designed grating pattern are 0.8 and 2 µm, respectively. The SCM image clearly shows the existence of a transition region at each pattern edge of which the width reveals the carrier concentration gradient of the lateral p-n junction. For the same anneal time, the sample annealed at 850 °C exhibits a wider transition region than the one at 1050 °C, indicating that more electrically active boron atoms can be obtained at higher anneal temperatures. The SCM signal intensity, i.e., dC/dV, is a function of the free carrier concentration of the implanted region. Comparing the dC/dV profiles across the implantation pattern for the samples treated under different RTA conditions, one can find that less implanted boron atoms at the pattern edge are electrically activated than at the center region. According to this study, the edge effect will significantly affect the lateral carrier concentration distribution upon RTA processes when the pattern size decreases.

AS-TuP2 Development of a Large Area XPS Imaging Instrument, *T. Tazawa, M. Kato, M. Kudo,* ***Y. Iijima***, *K. Tsutsumi*, JEOL Ltd., Japan

Recently, the photoelectron image measurement by XPS has become a very general surface analysis method. However, the measurement over the whole sample surface is very difficult because the measurable image region by the micro analysis in XPS is small. We developed an XPS instrument which is able to measure the region covering from 30x30µm^2 to 50x18mm^2. The photoelectron image measuring method is the stage scanning method. The minimum image resolution of this instrument is 30µmm or less. For this instrument, a newly designed magnetic lens was developed to achieve a better performance than the static lens system. This magnetic lens to measure a micro area is placed under the sample stage. In addition, the X and Y axes of sample stage can be operated by an accuracy of 1µm. The maximum operation ranges of the X and Y axes are 0-50mm and 0-18mm, and they are controlled by a PC system. We obtained photoelectron images of a polymer surface and a hard disk surface with this XPS instrument, polymer surface and hard disk surface. The results show that the large area XPS imaging analysis is very effective in the measurement of element distribution and chemical states of the sample surface by surface analysis. So we can say this instrument as "Chemical state image XPS". Moreover, the total reflection XPS (TRXPS) measurement function was added to this XPS instrument. TRXPS is a new surface analysis method, has sensitivity several times higher than XPS in surface analysis of the semiconductor such as Si wafers.

AS-TuP3 Compensating for the Ubiquitous Hydrocarbon Overlayer to Enable Quantification of the Elemental Composition from XPS; the Air-formed Film at the Aluminium Surface, *M.R. Alexander, G.E. Thompson,* ***X. Zhou***, UMIST, UK, *G. Beamson*, Daresbury Laboratories, UK

Air-formed and anodic films at the surface of aluminium are of considerable technological importance. The chemistry of the surface is relevant to the performance of coated and bonded aluminium; XPS is a powerful tool in characterising this surface.[1] Unfortunately, when an overlayer of hydrocarbon contamination is present on the air-formed oxide film, quantification of the elemental composition using XPS requires a correction to account for the greater attenuation of lower KE photoelectrons. Different methods have been developed to correct for this effect that do not require etching or angle resolved measurements. These include the Ebel model and modifications of this approach,[2] the Evans approach[3] and the Vereecke and Rouxhet method.[4] Application of these methods is compared for a range of overlayer thickness using a plasma polymerised hexane coating (ppHex) as a model for hydrocarbon contamination. The thickness was measured using in situ quartz crystal microbalance, XPS signal attenuation and TEM. A stable and reproducible hydrothermally-formed pseudoboehmite (AlOOH) sample is used with hydrocarbon contamination as low as [C]=1 at%.[5] Application to relevant systems is considered.

[1] M. R. ALEXANDER, G. E. THOMPSON and G. BEAMSON, Surface and Interface Analysis 29 (2000) 468.

[2] M. EBEL, M. SCHMID and A. VOGEL, J Electron Spectroscopy and Related Phenomena 34 (1984) 313.

[3] S. EVANS, Surface and Interface Analysis 25 (1997) 924.

[4] G. VEREECKE and P. ROUXHET, Surface and Interface Analysis 27 (1999) 761.

[5] M. R. ALEXANDER, S. PAYAN and T. M. DUC, Surface and Interface Analysis 26 (1998) 961.

AS-TuP4 Multivariate ToF-SIMS Image Analysis of Patterned Protein Surfaces, ***B. Wickes***, *D.G. Castner*, University of Washington

Novel biomaterial surfaces are being developed to specifically interact with their biological environments. These surfaces are patterned with multiple species of biomolecules to generate regions of differing bioactivity. The chemical structure of these surfaces must be characterized at high spatial resolution. Static Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS) imaging offers a modality for simultaneously visualizing the spatial distribution of multiple surface species. Because ToF-SIMS images yield a full mass spectrum at each pixel, it is possible to use characteristic mass fragments to identify and differentiate regions of different chemistry with a spatial resolution of approximately one micron. However, these datasets can be challenging to analyze because of their large size, complex chemistries and low ion counts per pixel. The combination of spectral data denoising and multivariate image analysis provides a convenient method to process ToF-SIMS images. Wavelet filtering followed by Principal Components Analysis (PCA) was applied to ToF-SIMS images. For example, the raw image data from a patterned poly(ethylene oxide) (PEO)-protein surface showed contrast in over 50 peaks; the resulting PCA model compressed the contrast from the raw data into two variables describing the variation between the protein- and PEO-regions, and the background and a defect region, respectively. Applying PCA to filtered image matrices removes user bias in peak selection and allows use of the full mass spectrum at each pixel. It highlights the peaks important in the chemical image and yields a new set of variables identifying the chemistries responsible for the image contrast.

AS-TuP5 Thermally Isolated Support Membrane for Low-noise Si JFET Amplifiers, ***Y. Bae***, *J. Podosek, M. Yun, J. Bock, K. Sukhatme, E. Jones*, Jet Propulsion Laboratory

A thermally isolated JFET module was fabricated at JPL to work with a high-sensitivity Bolometer that operates at a low temperature, ~300mK. The JFET module provides 24 differential pairs of JFETs, which need be warmed to 130K to provide optimal noise performance, 7nV/rtHz. Each channel has 2 feedback resistors and source, drain, gate, etc. electrical leads. However, power from the JFET electronics is dissipated on the 10K helium vapor-cooled stage of the Herschel cryostat, and the dissipation needs to be minimized to not affect the hold time and temperature of the liquid-helium. Although the JFETs are capable of satisfying the noise and power requirements, the design of the thermal isolation stage dominates the thermal dissipation requirement and presents a significant design challenge. We have devised a novel suspended nitride membrane to provide thermal isolation while satisfying the vibration and thermal cycle environment of a cryogenic space borne instrument. The JFET module needs to meet Bolometer's setup requirements: 1) a voltage noise performance less than 7nV/rtHz/JFET and 2) heat dissipation less than 3.5mW/module. Siliconix U401 JFET differential amplifiers must be heated to 130K to meet the 7nV/rtHz noise requirement. The silicon nitride membrane acts as a 2-D heat flow, so minimizing its thermal conductance is best achieved by reducing the membrane thickness or perforating the membrane. We present tests of the thermal conductance of several membrane architectures, and have carried out through testing of a complete 1.8micron silicon nitride assembly populated with JFET dies. The complete JFET module was characterized in functions of the power and voltage noise. The module passed shock environment test, 15g 400 - 2500Hz sine sweep, and passed thermal cycling to 77K, however it exceeded the heat dissipation requirement. Our test data on thinner membranes indicates we can meet the dissipation requirement with a 1.0micron membrane.

AS-TuP6 Non-destructive Depth Profiling Analysis of Surface Oxidation of b-$FeSi_2$ Thin Film on Si (100) by SR-XPS, ***T. Saito***, *H. Yamamoto, K. Yamaguchi,* Japan Atomic Energy Research Institute, *M. Haraguchi,* Ibaraki University, Japan, *T. Nakanoya,* Japan Atomic Energy Research Institute, *M. Imamura, N. Matsubayashi, T. Tanaka, H. Shimada,* National Institute of Advanced Industrial Science and Technology, Japan, *K. Hojou,* Japan Atomic Energy Research Institute

The formation process of iron silicid (β-$FeSi_2$) films on Si single crystal surfaces has been extensively studied because of their excellent characters as semiconductors. It is well known that stable β-$FeSi_2$ films are not oxidized even under ambient atmospheres. However, the oxidation behaviors of the topmost surface layer of β-$FeSi_2$ are not well understood. In the present study, we investigated the surface oxidation of β-$FeSi_2$ thin films formed on a Si (100) surface by means of synchrotron radiation X-ray photoelectron spectroscopy (SR-XPS) to obtain the information on the surface chemical state and the depth distribution of chemical components. The β-$FeSi_2$ films (10 - 100 nm) were formed by ion beam sputter deposition method (IBSD) or solid phase epitaxy method (SPE) at a substrate temperature of 973 K. After formation of β-$FeSi_2$ phases, the samples were exposed to oxygen or air at room temperature. SR-XPS depth-profiling analyses revealed formation of β-$FeSi_2$ islands on the substrates. The comparison of experimental results with simulation results using inelastic mean free paths (IMFP) of photo-electrons in Si and Fe revealed that about 50 - 70 % of the substrates surface were covered by β-$FeSi_2$ phases. In addition, the topmost surface of β-$FeSi_2$ and exposed Si substrates are almost completely covered by uniform thin SiO_2 layers. The thicknesses of the oxide layers were estimated at about 1.0 nm. These results indicated that thin surface SiO_2 layers behaved as a protective layer for further oxidation of β-$FeSi_2$ surfaces.

AS-TuP7 Surface Characterisation of Fluorinated Polyether Ionomers from Aqueous Dispersions, ***R. Canteri***, *G. Speranza, M. Anderle,* ITC-irst Centre for Scientific and Technological Research, Italy, *S. Turri, S. Radice,* Ausimont Spa Research & Development Centre, Italy

The introduction of perfluoropolyether (PFPE) bifunctional macromers, in polyurethane coatings[1,2] has lead to a substantial improvement of the durability characteristics and surface properties of the material, while maintaining the advantage of an easy application technology in a variety of environmental conditions and temperatures.[3] In this work we present a surface characterisation by TOF-SIMS and XPS of a new series of polymer thin films containing PFPE macromers, applied in form of PolyUrethane Aqueous Dispersions (PUAD). In fact, environmental issues are forcing the development of waterborne polymer systems (dispersions or emulsions) in order to reduce the problems of solvent emissions in the atmosphere. The PUAD systems presented in this work can be defined as polyurethane ionomers, since self-dispersion in water is achieved by using co-monomers containing a NR_3 or a -COOH group, which can be salified with acids or bases. It is known that many of the performances of the coating, like low surface energy (water and oil repellence), lubrication and low friction etc, are related to the capability of fluorinated structures to stay close to the polymer-air interface. The analysis of the outermost layer of the dried waterborne coatings by TOF-SIMS is compared with analyses by XPS obtained at two different angles (90° and 15° take off angle) for sampling different thickness. These results are finally compared with those obtained on the solventborne crosslinked coatings[4] containing similar PFPE macromers.

[1] G. Simeone, S. Turri, M. Scicchitano, C. Tonelli, Angew. Makromol. Chem. 236 (1996) 111.

[2] S. Turri, M. Scicchitano, G. Simeone, C. Tonelli, Progr. Org. Coat. 32 (1997) 205

[3] J. Scheirs, S. Burks, A. Locaspi, Trends Polym. Sci. 3 (1995) 74

[4] S. Turri, S. Radice, R. Canteri, G. Speranza and M. Anderle, Surface and Interface Analysis 29 (2000) 873.

AS-TuP8 A New Transparent Conducting Oxide: Indium Molybdenum Oxide (In_2O_3 : Mo), ***Y. Yoshida***, Colorado School of Mines, *T.J. Coutts, T.A. Gessert*, National Renewable Energy Laboratory

We report our preliminary work on a new transparent conducting oxide, indium molybdenum oxide (IMO, 4% Mo), prepared by radio frequency magnetron sputtering (RF sputtering). Other works have recently reported that thermal reactive evaporated thin films of IMO showed an exceptionally high mobilities of 80 - 130 $cm^2 V^{-1} s^{-1}$.[1] To study further the functionality of molybdenum in IMO, and to test if the large-area deposition capability afforded by RF sputtering can produce high mobility, we produced In_2O_3 (IO) and IMO films in an argon and oxygen atmosphere at a substrate temperature of 350°C. Electrical properties were studied as a function of the ratio of oxygen to argon (O_2/Ar) from 0 to 1. We found that the best film properties resulted when a small O_2/Ar ratio was used ($\leq$ 0.3). IMO films grown at 0.005 O_2/Ar achieved a mobility of 37.5 $cm^2 V^{-1} s^{-1}$, a carrier concentration of 1.16 x 10^{20} cm^{-3}, a resistivity of 5 x 10^{-3} Ω-cm, and ~70% transmission in a visible range (400nm - 900nm). IO film quality was optimized at ~0.025 O_2/Ar, resulting in a mobility in the range of 20 - 30 $cm^2 V^{-1} s^{-1}$, carrier concentration of 2.03 x 10^{18} cm^{-3}, and resistivity of 9.98 x 10^{-2} Ω-cm. IMO films showed much better electrical properties than the undoped IO films grown under the same range of conditions. X-ray photoelectron spectroscopy (XPS) confirmed the presence of molybdenum 6+ in the films. X-ray diffraction (XRD) analysis confirmed phase purity in the films and possible texture changes due to variations of the amount of oxygen in the system.

[1] Y. Meng, X. Yang, H. Chen, J. Shen, Y. Jiang, Z. Zhang, Z. Hua, Thin Solid Films 394 (2001) 219.

AS-TuP9 SIMS Analysis of Copolymers: A Test for Statistical Ordering, *A.G. Shard,* University of Sheffield, UK, ***S. Clarke***, *M.C. Davies,* University of Nottingham, UK

Statistical copolymers of lactic and glycolic acids (PLGA) have been investigated by SIMS. The composition of the copolymer can be determined through analysis of the intensities of secondary ions which contain several monomer units, as described previously for non-statistical copolymers.[1] We describe here a method for determining whether the SIMS data are consistent with the copolymer being statistical. This method is applicable to any copolymer, the only requirement being the detection of secondary ions containing two or more monomer units. This information is used to determine the relative ion yields of selected secondary ions in the SIMS spectra of PLGA and the invariance of ion yields across a large composition range is shown, validating our previous work.

[1] Shard AG, Davies MC, Li X, Volland C, Kissel T, Macromolecules 30, 3051, 1997.

AS-TuP10 Impurity Dopant Profile Measurement and its Quantitative Analysis using Nano Capacitance-Voltage (NCV) Method, ***E.-S. Kang***, *H.-J. Hwang,* Chung-Ang University, Korea, *G.-Y. Lee*, Samchok National University, Korea

It is well known that commercial scanning capacitance microscope (SCM) systems are not easy to obtain the local dC/dV curves over the dopant range of 1020 - 1018cm-3 because of smaller depleted volume charges generated under the surface by SCM tip size. This problem will prevent us from acquiring quantitative carrier depth information correctly. To do this, it needs the developing of robust capacitance sensor and the more powerful SCM modeling. For the more accurate inverted dopant profile in higher dopant area, therefore, we have added some factors such as SCM tip/sample interaction and fully calculated volume charges into previous modeling parameters. In addition, we have developed a new capacitance sensor operating about 1.7GHz frequency bandwidth. The capacitance sensor used in commercial SCM has been using the amplitude modulation method. However, we have taken the frequency modulation technique for increasing the accuracy in higher dopant area. This new capacitance sensor consists of a voltage-controlled oscillator with controlled voltage, a microstrip resonator, and a RF mixer IC and PLL (Phased-Lock Loop) for detecting the capacitance variations. We have called this system Nano Capacitance-Voltage (NCV). This technique will bring a greater enhancement for the current SCM sensitivity and performance.

AS-TuP11 A Quantitative Comparison between Rutherford Backscattering and Time-of-Flight Medium Energy Backscattering, *B.R. Rogers,* ***R.D. Geil***, *Z. Song, D.W. Crunkelton, R.A. Weller, V. Pawar,* Vanderbilt University

Both conventional Rutherford backscattering (RBS) and time-of-flight medium energy backscattering (ToF-MEBS) have been used to determine the thickness and stoichiometry of thin dielectric films (Al_2O_3) deposited on silicon, and a comparison is made between the two ion beam techniques. The characterization of these films is important in optimizing the deposition process and ultimately the film properties. The conventional RBS and ToF-MEBS systems are capable of 1.8 MeV and 270 keV He^+ beams, respectively. ToF-MEBS is a lower energy derivative of conventional RBS that offers improved depth resolution and sensitivity at the expense of total analyzable depth and ease of use.[1] Channeling was performed with both systems to suppress the substrate signal and enhance the signal from the thin dielectric film. Grazing angle analysis was performed with the RBS system to increase particle path length in the sample, thereby improving depth resolution. It was found that for films less than about 200 Å RBS had little sensitivity to the thin Al_2O_3 films while ToF-MEBS detected Al and O in films that were tens of angstroms in thickness.

[1] Weller, Robert A. Introduction to Medium-Energy Ion Beam Analysis. Methods in Materials Research (2000) 12b.1.

AS-TuP12 SIMS Depth Profiling of Multilayer Structures, ***A. Godines***, *Yu. Kudriavtsev, A. Villegas, R. Asomoza*, CINVESTAV-IPN, Mexico

In this work we performed a comparative study of the depth resolution function for metal and semiconductor multi-layers in depends on primary ion kind, primary ion energy and angle of incidence. Influence of oxygen flooding on the depth resolution was analyzed as well. Subject of our study was different test semiconductor multi-layers grown by MBE: AlAs/GaAs, AlGaAs/GaAs, GaAsN/GaAs, InGaAs/GaAs, AlGaN/AlN, as well as metal multi-layers (neutron super-mirrors): Co/Ti and Si/Fe. The number of layers has varied from 20 to 200; the thickness of an individual layer has varied from 1 monolayer to about 20nm. Sputtering was performed by cesium and oxygen positive ions. SIMS depth resolution depends on many different factors and effects such as surface roughness and surface roughness caused by ion bombardment, ion mixing effect, radiation enhanced diffusion and so on. In our work the ion mixing was found as the main effect affecting the depth resolution of semiconductor multi-layers. Parameter, which characterizes it, was found being proportional to the root square of the primary ion energy, normalized on the cosine of the angle of incidence, for both metal and semiconductor multi-layers. We did not find any mass dependence of the depth resolution that is in a contrast with the ballistic mixing model. Oxygen ion bombardment leaded to a dramatic reduce of the depth resolution in the case of metal multi-layers, because of a strong surface roughness formation. Moreover, a strong matrix effect was found at the interfaces of metal layers, which was more pronounced in the case of cesium ion bombardment. In order to reduce the matrix effect, we applied the oxygen flooding. This technique: Cs+ ion bombardment with CsM+ (where M is the analyzed element) secondary ions monitoring and with simultaneous oxygen flooding was found as the best method for metal multi-layer depth profiling.

AS-TuP13 Sample Topography Developed by Sputtering in Cameca Instruments: an AFM and SEM Study

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Secondary ion mass spectrometry (SIMS) is based on ion sputtering. Removing atoms layer by layer we can get a satisfactory depth distribution analysis. To obtain a suitable depth resolution for semiconductors applications low impact energy and glancing angles are mandatory. However high dose ion bombardments results in a change of surface topography causing problems in quantitative analysis and depth resolution deterioration. The morphological artefacts on the crater surface, depend on various SIMS sputtering parameters and samples conditions. The induced morphology by ion sputtering require detailed characterization. In this work we analysed, by using of Atomic Force (AFM) and Scanning Electron (SEM) Microscopies, the morphological effects induced by ion bombardment on various samples: monocristalline Si <100>, polycrystalline Si and amorphous silicon oxide. Topographic irregularities, induced by SIMS analysis are studied showing the dependence on sputtering condition. We used different instruments (Cameca Sc-Ultra and Cameca 4f) comparing the effect of analytical conditions as impact angle, incidental ion species, ion dose and impact energy. The goal is to determine best parameters to minimize roughness and surface irregularities considering or not the employment of the sample stage rotation.

AS-TuP14 Comparison of Experimental Protocol for Low Energy Sputter Yield Measurements of Advanced Materials as a Function of Sputtering Angle

*, **V.S. Smentkowski**,* General Electric - Global Research Center, *S. Hu*, Lockheed Martin

We will report two different experimental protocol that can be used to measure the sputter yield of advanced materials as a function of sputtering angle. One protocol uses standard surface analytical instrumentation while the second protocol utilizes a home built system containing a broad-beam (Kaufman) ion source. Low energy (350 eV and below) Xe was used for all measurements. When the samples were sputtered at normal incidence, the data generated using the two protocol agreed, however as the sputtering angle increased a divergence was noted in the data sets. It will be demonstrated that the divergence correlates with a change in the surface topography, which biases the data generated using one of the protocol. As part of this study, we measured the sputtering yield of silicone dioxide thin films obtained from different vendors and noted that the yield varied. Possible explanations for this effect will be reported. We believe that effects such as these are partially responsible for the lack of agreement in other sputter yield measurements reported in the literature.

AS-TuP15 Mathematical Topographical Correction of XPS Images using Multivariate Statistical Methods

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For rough heterogeneous samples, the contrast observed in XPS images may result from both changes in elemental or chemical composition and sample topography. Background subtraction is frequently utilized to minimize topographic effects so that images represent concentration variations in the sample. For this purpose, background images are recorded at slightly lower and/or higher binding energies than the main peak for all species of interest. Background-corrected images result from subtracting a background energy map from one acquired at the peak energy. This procedure may significantly increase the data acquisition time. Multivariate statistical methods can assist in resolving topographical and chemical information from images. Principal Component Analysis (PCA) is one method for identification of the highest correlation/variation between the images. Topography which is common to all of the images will be resolved in the 1st most significant component. The score of this component contains spatial information about the topography of the surface, while the loading is a quantitative representation of the topography contribution to each elemental/chemical image. Reconstructing the data using the score and loading for the 1st component will provide mathematical background images. These images, which contain the topographical information for all elemental/chemical images, can be used to correct the images for topography in the same way the experimental background images are used, thereby reducing the time required for data acquisition. The mathematical background correction scheme is developed and validated by comparing results to the experimental background correction for three samples with differing degrees of topography. The first example is a very rough, fossilized sample, the second is a patterned sample with roughness on the order of the XPS sampling depth and the third is a flat polymer blend sample. This work has been partially supported by NSF CHE-0113724.

AS-TuP16 High Spatial Resolution XPS Analysis of Si Samples Prepared using the FIB Lift-out Technique

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The goal of this project is to assess Ga+ contamination on Si in order to elucidate artifacts due to focused ion beam (FIB) milling. The FIB instrument has witnessed an increase in use from machining and processing to specimen preparation. However, the surface chemistry alterations, gallium implantation damage region, and residual effects of FIB sample preparation are not well understood. It is imperative that we understand the chemical and morphological alterations that this instrument may cause to its target, if correct interpretations regarding structure/property relationships of materials are to be made. FIB is currently most often used to prepare samples for microscopic techniques such as TEM, which have a higher spatial resolution than most surface analysis methods. Improvements in imaging and small area analyses have made X-ray photoelectron spectroscopy (XPS) an increasingly useful characterization technique for such samples, however. Utilizing spectra-from-images capabilities enables the acquisition of spectra from areas of ~ 1 micron in diameter, allowing for surface chemical characterization of FIB lift-out samples. This poster will discuss the use of XPS imaging and small area spectroscopy to characterize surface oxidation and Ga contamination in Si (100) prepared by the FIB lift-out method.

AS-TuP17 Elucidation of Three-Dimensional Structure in Polymer Blends using Correlated Confocal Microscopy and XPS Imaging

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The complexity of heterogeneous polymeric materials makes it difficult to distinguish between alternative morphologies using a single analytical technique. Knowledge of both polymer surface chemistry and component distribution with depth can be important. In this study, blends of poly(vinyl chloride) (PVC) and poly(methyl methacrylate) (PMMA) have been investigated using confocal microscopy and imaging XPS. Confocal microscopy provides the distribution of phase separated areas as a function of depth (on a scale of microns), while XPS provides the surface distribution of phase separated regions. Conclusions based upon these comparisons will be compared to previous work from our group using imaging FTIR. This has been partially supported by NSF ALCOM and NSF CHE-0113724.

AS-TuP18 Correlative XPS and AFM: Chemical Phase Identification in Polymers

*, **J. Farrar**, K. Artyushkova, J.E. Fulghum,* Kent State University

AFM can be utilized to provide both topographical and phase contrast information from polymeric materials. AFM phase contrast images potentially contain chemical information, although image interpretation can be challenging. XPS images contain chemical phase information, but at a significantly different spatial resolution. In this study we evaluate methods for the correlation of images with varying spatial resolutions, focusing on XPS and AFM. Processing for image correlation includes resizing, image alignment and resolution matching. Following imaging processing, classification methods are used to correlate components present in XPS and AFM images. Data from a variety of polymer samples will be used to demonstrate that classification of XPS and AFM images can be used to identify chemical phases in AFM images. This work has been partially supported by NSF ALCOM (DMR89-20147) and NSF CHE-0113724.

AS-TuP19 Surface Studies of Corrosion of Stainless Steel by Lead-Bismuth Eutectic, ***A.L. Johnson***, *D. Koury, B. Hosterman, D. Parsons*, University of Nevada, Las Vegas, *D. Perry*, Lawrence Berkeley National Laboratory, *J. Farley*, University of Nevada, Las Vegas

The corrosion of stainless steel by lead-bismuth eutectic (LBE) has been studied using various types of surface analysis, including Scanning Electron Microscopy (SEM) and X-ray Photoelectron Spectrometry (XPS). The goal is to understand the chemical react ion products and chemical reactions involves in the corrosion. The atomic composition of steel samples has been examined as a function of position. Sputter depth profiling has been employed to study the atomic composition as a function of depth. High resolution XPS studies reveal the oxidation state of the various elements. We have examined both unexposed steel samples and steel samples that have been exposed to LBE for various lengths of time for different temperatures. Crucial differences between the un exposed and exposed samples are demonstrated in the data. For example, nickel is present at the surface of the unexposed samples, but absent from the exposed samples. The latest experimental results will be presented and mechanistic implications discussed. This work was supported by the U. S. Department of Energy under the AAA UPP Program (UNLV) and Contract Number DE-AC03-76SF00098 (LBNL).

AS-TuP20 Initial Tests of a Draft Protocol for Wide Scan XPS Measurements, ***M.H. Engelhard***, *D.R. Baer*, Pacific Northwest National Laboratory

In May 2002 an international workshop on developing an expert XPS system was held in St. Malo, France. One output of that workshop, developed by a task group lead by Prof. James Castle, was a draft protocol for collecting a maximum amount of information from wide scan data. Although similar to approaches already used in some laboratories, the protocol is significantly different than the default wide scan spectra for most instruments and suggests that a significant amount of information can be routinely extracted from wide scan data that is generally ignored or missed. Although parts of the draft protocol (step size, scan width and preliminary charge correction) are common practice for use of our Quantum 2000, other parts (energy resolution, analysis for layered structure) are different than our usual practice. This paper reports our preliminary experience in a manual application of the initial version of this draft protocol to "routine" samples in our laboratory.

This work was conducted in the Environmental Molecular Sciences Laboratory, a U. S. Department of Energy User Facility run by Battelle Memorial Institute.

AS-TuP21 Surface Characterization of Nanoparticles for Cast Dispersion Strengthened Metal Matrix Nanocomposites, ***A.L. Linsebigler***, *V.S. Smentkowski, T. Angeliu*, General Electric Global Research Center

Oxide dispersion strengthened (ODS) metal matrix composites possess very stable nano-particles that provide strength at elevated temperatures, but have found limited commercial application due to complex processing and cost constraints. Solidification processing has been pursued as one of the most cost effective and versatile methods to produce metal matrix composites. However, composites produced by casting have significant challenges in wetting the surface of an oxide particle by molten metal. Particle wetting can be influenced by physisorbed and chemisorbed surface species and oxide stoichiometry. Surface characterization studies have been conducted on as-received and heat-treated alumina nanoparticles by SEM, AES, TOF-SIMS, and TPD methods. The roles of adsorbed species and surface functionalization on the wetting and dispersion of these nanoparticles in metal alloy matrices will be discussed.

AS-TuP22 Basic Characterization of Arcing in Sputtering Targets, ***F.G. Tomasel***, *D. Carter, H. Walde, J.J. Gonzalez, G.A. Roche*, Advanced Energy, Inc.

Arcing in sputtering deposition is a very well known phenomenon that affects quality of thin films. Different strategies have been devised to reduce arcing during the deposition process. However, it is felt that there is still a need for a further description of the basics of arc formation. This article intends to contribute in this subject by presenting a detailed description of the formation and evolution of arcs. The study combines the spatial and time resolved results of ultra high-speed, single frame photographs with an electrical characterization of the current and voltage waveforms for arcs occurring on different sputtering targets. Elaborating on these data, we will present a possible explanation for the results observed.

AS-TuP23 Characterization of Plasma Source Ion Implanted Stainless Steel for High Voltage Applications, ***N.D. Theodore***, College of William and Mary, *C. Hernandez*, Jefferson Lab, *D.M. Manos*, College of William and Mary, *H.F. Dylla*, Jefferson Lab, *R. Moore*, University at Albany Institute for Materials, *T. Siggins*, Jefferson Lab

Properly modifying the surface of stainless steel to increase efficiency or output power is useful in high voltage electrical pieces seen especially in particle accelerators for research and medicine, high-power radar, DC electron guns, and high power microwave tube and waveguide systems. In this study, highly polished stainless steel test pieces were processed in our integrated PSII/PVD system, which is capable of implanting ions while simultaneously depositing high purity SiO_2. Previous studies have shown that the suppression of field emission is enhanced in harder, smoother surfaces, and that nitrogen-implanted stainless steel increases surface hardness. Our recent work has shown that the suppression of field emission increases by an order of magnitude in surface-processed samples.[1] This study compares the surface character of unprocessed stainless steel with nitrogen-implanted stainless steel and nitrogen-implanted, SiO_2-deposited stainless steel using electric field microscopy, atomic force microscopy, micro-hardness testing, and Auger electron spectroscopy. The relative effectiveness of various surface-processing methods in reducing field emission will also be discussed. This work supported by the US Dept. of Energy and the Office of Naval Research.

[1] C. K. Sinclair, et al. "Dramatic Reduction of DC Field Emission From Large Area Electrodes By Plasma Source Ion Implantation." Proceedings of the 2001 Particle Accelerator Conference.

AS-TuP24 Nano-scale Mapping of Surface-photo-voltage by Scanning Tunneling Microscope : Ag/Si(001), ***O. Takeuchi***, *S. Yoshida, H. Shigekawa*, University of Tsukuba, CREST, Japan

It has been a subject of great interest to investigate the nanoscale spatial distribution of surface photo voltage (SPV) on semiconductor surfaces. In general, SPV measurement studies the change in band bending at semiconductor interfaces as a function of the external illumination, which offers information about local band diagram including band gap structure and mid-gap confined states as well as local density, diffusion length and lifetime of carriers. Thus, measurement of SPV with high spatial resolution opens a way for precise control of defect and dopant density in a specific nanostructure and investigation of its characteristics. In this study, we have mapped the nano-variation of SPV for partially covered Ag/Si(001) system with conventional scanning tunneling microscope (STM) from OMICRON, in UHV at 300 K and 80 K. To measure SPV, current-voltage curve (IV curve) measurement was performed while 2 mW HeCd laser beam was focused onto tunneling gap with mechanical chopping at 20 Hz. The spot diameter was about 0.1 mm. Since, the obtained IV curve gives the IV curves on dark and illuminated conditions simultaneously, SPV can be retrieved as lateral displacement of the two IV curves as a function of bias voltage. Spatial mapping was realized by performing the SPV measurement in grid points during conventional STM topograph imaging. Clear dependence of SPV on the distance from the two-dimensional Ag islands as well as linear dependence of SPV on bias voltage with static tunnel gap distance was observed.

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