Vacuum Metallurgy Division
Room 4C - Session VM-TuP

Poster Session

VM-TuP1 Pattern Writing by Implantation in a Large-scale PSII System with Planar Inductively Coupled Plasma Source*, **L. Wu**, D.M. Manos, T.J. Venhaus,* College of William and Mary

A large-scale PSII system has been built. With chamber 28.5in in diameter and 20in tall, pulses of up to 100KV, and base pressure in the 10@super -8@torr range, it is one of the largest PSII systems. It has been operated with hot filament, hollow cathode and recently with 22.5-inch diameter quartz window for planar RF ICP. This paper compares implantation with these plasma sources, demonstrating the advantages of RFI. It also reports measurements of the plasma density and spatial distribution using Langmuir probe for different RF power, gas pressure and plasma compositions for implanting alloys. Results of implanting alloys including large-area stainless steel cathodes to reduce field emission are reported. Metallic and semiconductor samples have also been implanted through masks with various plasma compositions to produce small geometric patterns of interest for device manufacturing. The samples are characterized by variable-angle spectrometric ellipsometry (VASE), SEM, AES, SIMS, and XPS, and for electrical and mechanical properties. Depth profiles obtained by VASE, SIMS, AES and XPS are compared to Monte-Carlo calculations (Tri-Dyn, Trim, ProfileCode). Measured lateral and depth profiles are compared to the mask features to assess lateral diffusion, pattern transfer fidelity, and wall-effects on the depth profile. The paper also presents the results of MC-hybrid and PIC calculations of the flux and angle of ion trajectories through the boundary layer predicting the uniformity of flux as a function of 3-D location on objects in the expanding sheath and to evaluate the fidelity of pattern transfer as a function of feature size. Sample heating and diffusion effect is included.

VM-TuP2 Growth of SiC Thin Films on Graphite for Oxidation Protective Coating*, **J.-H. Boo**, M.C. Kim, C.H. Heo, S.-B. Lee, S.-J. Park, J.-G. Han,* SungKyunKwan University, Korea

We have deposited thick SiC thin films on graphite substrates in the temperature range of 700 - 850 @super o@C using single molecular precursors by both thermal MOCVD and PEMOCVD methods for oxidation protection wear and tribological coating. Two organosilicon compounds such as diethylmethylsilane (DEMS), (Et)@sub 2@SiH(CH@sub 3@), and hexamethyldisilane (HMDS), (CH@sub 3@)@sub 3@Si-Si(CH@sub 3@)@sub 3@, were utilized as single source precursors, and hydrogen and Ar were used as a bubbler and carrier gas. Highly oriented polycrystalline cubic SiC layer in [110] direction was successfully deposited on graphite at temperature as low as 800 @super o@C with HMDS by PEMOCVD. In the case of thermal MOCVD, on the other hand, only amorphous SiC layers were obtained with either HMDS or DEMS at 850 @super o@C. From this experiment, we confirmed that PEMOCVD was highly effective process in improving the characteristics of the SiC layer properties compared to those grown by thermal MOCVD. The as-grown samples were characterized in situ with OES and RGA and ex situ with XRD, XPS, and SEM. The mechanical and oxidation-resistant properties have been checked. The optimum SiC film was obtained at 850 @super o@C and RF power of 200 W. The maximum deposition rate and microhardness are 2 µmm/h and 4,336 kg/mm@super 2@ Hv, respectively. The hardness was strongly influenced with the stoichiometry of SiC protective layers. Ar-plasma pre-treatment enhanced the hardness and adhesion between SiC layer and graphite substrate due to a nucleation effect.

VM-TuP3 Novel Technique for Low Temperature Chemical Vapor Deposition of Titanium Thin Films on Mild-Steel Surfaces for Corrosion Resistance*, **J.H. Hendricks**, M.I. Aquino, M.R. Zachariah,* National Institute of Standards and Technology

A novel, low temperature technique for growing titanium films on mild-steel substrates has been demonstrated. This method involves the use of a low pressure (600Pa) co-flow diffusion reactor in which sodium vapor and gas-phase titanium tetrachloride react in the presence of a non-reactive gas, Ar. The reaction chemistry is described by the following equation: 4Na(g) +TiCl@sub 4@(g) --@super Ar(g)@-->Ti(s)+ 4NaCl(g). In this reaction, a gas-phase alkali metal (Na) strips multiple halogen atoms (Cl) from a gas-phase metal halide (TiCl@sub 4@). This allows free Ti atoms to attach to a substrate surface placed within the reaction zone, resulting in the growth of a solid metal film. Previously, we have used this technique to grow Ti and TiN thin films on Cu substrates@footnote 1@ at 610°C and TiO@sub 2@ thin films on Si substrates@footnote 2@ at 600°C. This chemistry should be generic for the deposition of a wide class of metallic and ceramic thin films at deposition temperatures which are significantly lower than conventional techniques, and this technique could potentially be used to grow hard and superhard coatings such as CN and BN. Thermodynamics modeling was used to simulate the reactant concentrations and substrate temperatures at which the salt by-product remains in the gas-phase. The modeling predictions were compared to the experimental results and found to be in good agreement. Using the described technique, we have produced Ti thin films on mild-steel substrates with substrate temperatures of 400°C to 800°C. These temperatures are considerably lower than conventional CVD of Ti which involves the thermal decomposition of titanium tetraiodide at 1000°C to 1200°C.@footnote 3@ Lowering the temperature for Ti deposition on mild-steel is of significance since mild-steel undergoes a phase transition at 723°C.@footnote 4@ The corrosion resistance of the titanium coated mild-steel substrates were evaluated to determine the optimum substrate deposition temperature. The quality and composition of the thin films were analyzed by scanning electron microscopy (SEM), energy dispersive x-ray spectrometry (EDS), and x-ray diffraction (XRD). @FootnoteText@ @footnote 1@J. H. Hendricks, M. I. Aquino, J. E. Maslar, and M. R. Zachariah, Chem. Mater. 1998, 10, 2221-2229. @footnote 2@J. H. Hendricks, M. I. Aquino, J. E. Maslar, and M. R. Zachariah, Material Research Society Proceedings, Nov.30-Dec. 4, 1998, Boston, MA. @footnote 3@M. G. Hocking, V. Vasantasree, and P. S. Sidky, Metallic and Ceramic Coatings: Production, High-Temperature Properties and Applications, John Wiley and Sons: New York, 1989, p. 103. @footnote 4@J. M. Camp and C. B. Francis, The Making Shaping and Treating of Steel, United States Steel Company: Pittsburgh, PA, 1951, p. 1203.

VM-TuP5 Friction Evaluation and Development of Vacuum Materials for Tribological System*, **M. Tosa**, A. Kasahara, Y.S. Kim, K. Yoshihara,* National Research Institute for Metals, Japan

Vacuum materials for movement system requires small friction as well as low outgassing. Friction and outgassing strongly depends on the surface conditions and structures of the materials. It is therefore important to evaluate fiction accurately in-situ in a vacuum as controlling such surface layer structures as contaminates layer, adsorbed layer and oxide layer by changing load and vacuum pressure. We have developed a vacuum friction measurement apparatus to evaluate sliding friction under changing the load from 1N to 0.98 mN and under the vacuum pressure from 10@super5@ Pa to 10@super-8@ Pa. Two strain gauges measure the friction force occurred at the loaded pin on the substrate sheet. The measurement was carried out on the sheets for such vacuum materials as type 304 stainless steel, copper, hexagonal boron nitride (h-BN) segregated copper film on the stainless steel, sintered h-BN plate and titanium nitride (TiN) coated stainless steel. All steel sheets are polished mechanically with diamond powder of 0.3µm in grain size. Co-sputtering deposition of h-BN chips and a copper disc target prepared segregated h-BN film. Titanium nitride was coated on the stainless steel with magnetron sputtering deposition. The result of the measurement in decreasing the vacuum pressure shows that the friction coefficient of h-BN surface segregated copper film on steel keeps about 0.1, which is smaller than any other coefficient. The friction coefficient of copper and TiN coated steel decreased gradually but still larger than that of h-BN surface segregated copper film and the friction coefficient of stainless steel increases very much in decreasing the pressure. The result of the measurement in decreasing the load shows that the friction coefficient of h-BN surface segregated copper film on steel keeps smaller than that of copper and steel sheet. Hexagonal boron nitride segregated copper film can be therefore a good candidate material for vacuum tr! ibological system.

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