

Tuesday Afternoon Poster Sessions, November 1, 2005

Advanced Surface Engineering Room Exhibit Hall C&D - Session SE-TuP

Advanced Surface Engineering Poster Session

SE-TuP1 HPPMS Growth of High Sputtering Yield Metallic Films, S.L. Rohde, University of Nebraska; D.J. Christie, Advanced Energy; S. Sevvana, S. Chennadi, D.M. Mihut, J. Li, University of Nebraska

Ionization levels as high as 70-90% have been reported using High-Power Impulse Magnetron Sputtering (HPIMS), also known as HPPMS, as compared with 5-10% ionization typical in conventional dc magnetron sputtering. Unfortunately, the overall deposition rates observed in most HPPMS studies is significantly lower than (~30%) for conventional dc magnetron sputtering. In the present study, the deposition rate of HPPMS films has been studied as a function of the impulse voltage (or charge voltage). The studies have been carried out for both high sputtering yield metals including Al and Cu, as well as low sputtering yield compounds, such as CrB₂. While the overall deposition rate increases with increasing impulse voltage or pulse power; this relationship does not follow the same linear relationship observed for dc sputtering. Additionally, under specific conditions it has been shown that dynamic deposition rate [nm/(watt*s)] can exceed that obtained using comparable dc power levels. This trend is observed only for materials with very high sputtering yields, but in all cases there are distinct changes in film properties, such as texture, surface roughness and residual stress, as a function of impulse voltage or power. Other variables considered include: substrate bias, supplemental discharge confinement and angle of inclination. Discussed are some of the implications of and possible explanations for this variation in dynamic deposition rate, making it possible to envision applications where HPPMS techniques might have significant advantages over conventional magnetron sputtering.

SE-TuP2 Low Temperature Deposition of α -Al₂O₃ by Plasma Chemical Vapor Deposition, D. Kurapov, J.M. Schneider, RWTH Aachen, Germany

Al₂O₃ coatings were deposited on tempered hot working steel substrates (X38CrMoV5-1) by plasma enhanced chemical vapor deposition. The influence of the substrate temperature on the constitution of the alumina films was investigated in the temperature range from 500 to 600 °C and normalized ion flux values of 100, 140, 270, and 480. The constitution of the deposited films was analyzed by grazing incidence x-ray diffraction (GIXRD). Additional information about phases formed was obtained from atomic force microscopy (AFM) of polished films. It was found that the phase formation was strongly affected by the normalized ion flux. α -Al₂O₃ films were obtained at a growth temperature as low as 500 °C. The hardness and elastic modulus of the deposited films were evaluated by nanoindentation. The correlation between deposition parameters and mechanical properties of Al₂O₃ films can be understood in terms of the density reduction due to changes of the ion flux. It was found that maximum hardness and elastic modulus values were obtained at low normalized ion flux values.

SE-TuP3 Laser Processing of Crystalline Technologically Relevant Glass-Forming Alloys for Enhanced Corrosion Resistance, J.M. Fitz-Gerald, J.G. Hoekstra, M.A. Jakab, S.J. Poon, G.J. Shiflet, J.R. Scully, University of Virginia

Over the past 25 years, investigations concerning the use of continuous and pulsed lasers for surface modification have met with reasonable success in areas of alloying element modification, enhanced surface hardness, structure manipulation, and improvements in corrosion resistance. There are several critical attributes of laser surface modification (LSM) that lead to the formation of an amorphous surface, including the ability to promote near-surface compositional uniformity, and due to the use of a pulsed laser (nanoseconds), rapid solidification at quench rates on the order of 10⁸ to 10¹⁰ K/s are possible. Moreover, since only the first few micrometers are re-solidified, LSM presents the opportunity to explore the surface amorphization of materials without sacrificing desirable bulk properties such as strength and toughness. This research focuses on the Al-Co-Ce and Fe-Cr-Mo-Er-C-B alloy systems with enhanced glass forming chemistries. In this research, the homogeneity of the starting crystalline ingot has been found to have a major impact on the ability to form an amorphous surface. The LSM surfaces showed several amorphous characteristics in terms of backscattered imaging, diffraction spectra, and corrosion behavior, all of which are signatures of these classes of amorphous materials.

Electrochemical analysis of the modified materials showed increased pitting potentials and several characteristics similar to that of fully amorphous, melt spun metallic glass alloy standards. Characterization was performed with scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDXS), Auger electron spectroscopy (AES), conventional and glancing angle X-ray diffraction (XRD), and electrochemical analysis. @FootnoteText@ @footnote 1@ K.G. Watkins, M.A. McMahon, and W.M. Steen, Mat. Sci. and Eng. 231, p. 55 - 61 (1997).

SE-TuP4 Structure and Bonding of V@sub 2@AIC Studied by Theoretical and Experimental Means, J.M. Schneider, R. Mertens, D. Music, RWTH Aachen, Germany

We have studied V@sub 2@AIC (space group P6@sub 3@/mmc, prototype Cr@sub 2@AIC) by ab initio calculations and used DC magnetron sputtering to synthesize a thin film. The density of states (DOS) of V@sub 2@AIC for antiferromagnetic (AFM), ferromagnetic (FM), and paramagnetic (PM) configurations are also presented. Based on a comparison of the cohesive energies as well as the DOS for the spin polarized structures, we have identified the FM/AFM configuration to be metastable. According to our partial DOS analysis, V@sub 2@AIC can be described as a strongly coupled nanolaminate [Z. Sun, D. Music, R. Ahuja, S. Li, and J. M. Schneider, Phys. Rev. B 70, 092102 (2004)]. Furthermore, we have observed good agreement between the calculated and measured equilibrium volume.

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