Wednesday Evening, December 11, 2024

Thin Films and Surface Modification
Room Naupaka Salon 4 - Session TF2-WeE

Thin Films - Materials II

Moderator: Diana Berman, University of North Texas

7:40pm **TF2-WeE-7 On the Growth of Cubic Boron Nitride Thin Films Using High-Power Impulse Magnetron Sputtering**, ***Tetsuhide Shimizu**, H. Nagakura,* Tokyo Metropolitan University, Japan; *Y. Tokuta,* Tokyo Metropolitan Industrial Technology Research Institute, Japan; *I. Fernandez,* Nano4Energy, Spain; *R. Boyd,* Linköping University, Japan; *D. Lundin, U. Helmersson,* Linköping University, Sweden **INVITED**

To realize the growth of cubic boron nitride (c-BN) towards a full-scale industrial application of this coating materials, this work has been aimed to understand the discharge physics and growth kinetics in reactive high-power impulse magnetron sputtering (HiPIMS) of B_4C target in Ar/N_2 gas mixtures. Besides the developments of hard transition metal nitride coatings, c-BN coatings have been attracted because of its extremely high hardness, high thermal conductivity, high temperature resistance above 1000°C, and inertness to steel materials. Although a wide variety of deposition processes have been studied since 1990s, it has not yet been commercialized. One of the major challenges is the significant degradation of film adhesion due to the high residual stresses during the cubic phase formation. While the key to nucleation of the c-BN phase is the formation of “nano-arches” by ion bombardment on the turbostratic BN phase (t-BN), the bombardment by the gas ions, such as Ar^+ ions, leads to the entrapment of the gas atoms into the crystal lattice, causing the increase in residual stress.On the other hand, the time-transient discharge of HiPIMS makes the time separation of ion arrivals to the substrate and it enables the tuning of the incident ions and the independent control of their kinetic energy by using the synchronized pulsed substrate bias technology. This would realize the selective ion bombardment of film forming species, which is expected to result in efficient momentum transfer without introducing film stress through the rare gas incorporation. In addition, this great feature of the HiPIMS discharge allows us to systematically isolate the influencing factors and will dramatically advance the understanding of the nucleation physics of c-BN. In this study, the effects of ion acceleration schemes, including DC bias, synchronized pulsed bias and bipolar pulse configurations and their process parameters, such as the pulse duration, delay time and the substrate bias potential are thoroughly investigated, based on the mass-spectroscopy study of reactive HiPIMS discharge of B_4C target in Ar/N_2 gas mixture. In addition to the great importance of the bias potential, the obtained results clearly show the effect of the synchronized pulse duration and the time delay on the chemical bonding states of B-C-N films and its mechanical properties, due to the time domain of accelerated ions during film growth. By focusing on the average momentum transfer per deposited atom at each biasing condition, the role of the mass and flux of the incident ions on the formation of c-BN bonding state is discussed.

8:20pm **TF2-WeE-9 Physical Properties of Pure Vanadium Nitrides Thin Films**, ***Marjorie Cavarroc**, J. Neyrat,* Safran, France; *D. Marquez, D. Michau, A. Poulon-Quintin,* ICMCB, France

Transition metal nitrides coatings are widely studied because of their good optical, mechanical, thermal... properties. Depending on the microstructure, coatings present different properties. For vanadium nitride (VN), stable and metastable phases can be deposited as coatings. In this study, their physical and adherence properties on 316L stainless steel and AlN substrates depending on the microstructure and the thin film PVD technique used, are compared. Both Reactive High Power Impulse Magnetron Sputtering (R-HiPIMS) and Reactive RadioFrequency Magnetron Sputtering (RF-MS) were selected. Characterisations of structures and films microstructures were realised by *Grazing* Incidence X-Ray diffraction and Electron Microscopies (SEM and TEM). Scratch tests and nanohardness measurements were used to compare adherence and mechanical properties. OPtical properties were explored with a four-point probe.

The correlation between microstructure, process and physical properties is discussed. The aim of this study is to show the interest for specific applications of VN thanks to the quantification of its physical properties and/or tuning its microstructures.

8:40pm **TF2-WeE-10 Sputter Depth Profile Study of Zrn as a Barrier to Silver Migration in Triso Fuels Using the XPS Neo Artificial Intelligence Fitting Package**, ***Jeff Terry**,* Illinois Institute of Technology

We have measured simulated TRISO Fuel model structures of SiC and ZrN with and without a 2 nm carbon capping layer. We have used both Sputter Depth Profiling with conventional X-ray Photoemission (XPS) and Ambient Pressure X-ray Photoemission Spectroscopy (APXPS) to explore the reactivity of these layers with both Ag and H_2O. One set of the samples that were depth profiled were measured at room temperature. Another set was annexed to 500 °C and then cooled to room temperature before profiling. The samples measured with APXPS were exposed to 1 mbar of H_2O exposure and annealing up to 500 °C. The exposure was done in a near ambient pressure cell within the XPS system. High resolution scans of the Ag 3d, Zr 3d, O 1s, Si 2p, C 1s and N 1s region were collected and the peaks were fit to identify the chemical species as it is being exposed and annealed. The deconvolution was performed using our Artificial Intelligence analysis package XPS Neo. This study shows that materials used in TRISO fuel (SiC and ZrN) have a strong reaction to water and high temperature and having a barrier layer of carbon to can effectively prevent oxidation of the materials. The Ag is effectively stopped by the ZrN layer. Adding a layer of ZrN may prevent exposure to workers during shutdowns.

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