Advanced Surface Engineering
Room 2007 - Session SE1-ThM

Pulsed Plasmas in Surface Engineering
Moderator: J.M. Schneider, RWTH Aachen, Germany

8:00am **SE1-ThM1 Pulsed Metal Plasmas*, A. Anders,*** Lawrence Berkeley National Laboratory **INVITED**

A review is presented on pulsed metal plasmas used for surface engineering and thin film deposition. Pulsed laser ablation, pulsed (filtered) arc plasmas, and high power (im)pulse sputtering are the main approaches to producing pulsed metal plasmas. Each of them has a set of distinct properties. By partially or fully ionizing the metal (and background gas, if applicable) one can extend the possibilities of widely used physical vapor deposition (PVD) methods. The knowledge gained in the fields of plasma-assisted and ion-beam-assisted deposition (IBAD) can be applied: pulsed metal plasmas can be used for self-ion-assisted deposition. Effects of energetic condensation include interface mixing, densification, buildup of compressive stress, thermal spike annealing and stress reduction, and texturing for selected materials. This work was supported the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

8:40am **SE1-ThM3 Optimization of Adhesion Promoting Substrate Pre-Treatment using Metal Ions of a High Power Impulse Magnetron Discharge*, M. Lattemann,*** *U. Helmersson,* Linköping University, Sweden

A high power impulse magnetron sputtering (HIPIMS) plasma consists of a high amount of single- and double-ionized metal species identified by mass spectrometry. The resulting high metal ion-to-neutral flux on the substrate can be used for sufficient substrate surface cleaning and modification by applying a negative substrate bias U@sub b@ enhancing the adhesion of industrial-relevant coatings. The HIPIMS pre-treatment was carried out in an inert gas atmosphere at a low pressure of p@sub Ar@=1 mTorr to minimize the inert gas incorporation. The subsequently grown metal nitride coating (CrN, TiN, TiAlN) was deposited in an Ar/N@sub 2@ atmosphere using conventional dc magnetron sputtering. The microstructure and constitution of the interfacial region for different process parameters (substrate bias U@sub b@=0 - 1200 V, substrate temperature T@sub s@=RT - 450°C) was investigated employing Transmission Electron Microscopy (TEM) and Analytical Scanning Transmission Electron Microscopy (A-STEM), respectively. The critical load of failure values were determined in scratch tests (CSEM Revetest). The influence of the process parameters on the constitution and microstructure of the interfacial region after the pretreatment and its effect on the coating adhesion will be discussed.

9:00am **SE1-ThM4 Modulated Pulsed Power Generator for High Density Magnetron Discharges***, R. Chistyakov,* Zond, Inc.*; B. Abraham,* Zpulser*;* ***W.D. Sproul,*** Reactive Sputtering Consulting, LLC*; J.J. Moore,* Colorado School of Mines

A unique high power pulsed magnetron plasma generator has been developed to generate high density plasmas for sputtering applications with typical pulse durations in the range of 0.5-5 msec. By creating a combination of weakly-ionized and strongly-ionized plasmas by modulating the cathode voltage within a single pulse, highly ionized plasmas have been produced. Films of aluminum, copper, titanium, aluminum oxide, and titanium nitride have been deposited. The film structure and orientation are a function of the pulse shape and duration and the degree of ionization. Optical emission measurements show that there is a very high degree of ionization of the the sputtered species, and this high degree of ionization promotes the formation of the reactive films. For the aluminum oxide films deposited with an average power of 4.5 kW with a target to substrate distance of 23 cm, the deposition rate was 12 microns per hour. Possible applications for this new high power pulsed sputter deposition technology will be discussed.

9:20am **SE1-ThM5 Surface Wettability of Stainless Steel Treated using C@sub 2@H@sub 2@ Plasma using Plasma-based Ion Implantation*, T. Tanaka,*** *R. Wang, T. Takagi,* Hiroshima Institute of Technology, Japan

Plasma-based ion implantation (PBII) with negative voltage pulses to the test specimen has been applied to the surface treatment process as a technique suitable for three-dimensional work pieces. Also, the surface property of stainless steel for semiconductor process using corrosive gases is important. The surface of stainless steel was treated in C@sub 2@H@sub 2@ gas using Plasma base ion implantation (5 µsec pulse width, 300 pulses/s, -10 kV). The contact angle of a water-droplet on each specimen surface was measured by using a digital microscope and the contact angle was obtained. The contact angle of specimens without C@sub 2@H@sub 2@ plasma treatment was about 90 degree, while that of specimens with C@sub 2@H@sub 2@ plasma treatment was about 64 degree. It found that the surface wettability of stainless steel largely enhanced by the C@sub 2@H@sub 2@ plasma treatment using plasma-based ion implantation.

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