Plasma and Vapor Deposition Processes
Room Town & Country A - Session PP1-2-MoA

PVD Coatings and Technologies II

Moderators: Yen-Yu Chen, National Pingtung University of Science and Technology, Taiwan , **Christian Kalscheuer**, IOT, RWTH Aachen, Germany

1:40pm **PP1-2-MoA-1 Thick Uniform Coatings on Hollow Glass Microspheres via DC Magnetron Sputtering***, **Kira Shulman [kirashulman@lanl.gov]**,* Los Alamos National Laboratory, USA

While DC magnetron sputtering is excellent for coating planar substrates, coating spherical substrates is challenging due to the line-of-sight nature of this deposition process. To address this limitation, a method of agitation must be employed to keep these spherical substrates “rolling”, thereby exposing all substrate surfaces to the sputter source throughout the coating process. Furthermore, producing thick coatings on microscopic spherical substrates is problematic due to issues balancing production of larger batches with coating consistency. In this work, we develop a vibrating stage assembly to agitate hollow glass microspheres (HGMS) of

varying diameters and optimize coating parameters in order to produce thick uniform coatings via magnetron sputtering. The vibrating stage assembly provides the linear mechanical agitation necessary to allow for optimal intermixing of the HGMS, resulting in increased uniformity of the coatings. To address thickness concerns, we found that running coatings for longer periods of time as well as minimizing the distance from sputter source to substrate ensured optimal development of thicker coatings on smaller batches of HGMS. An eleven hour coating run with source-substrate distance at 6 inches produced 120 nm vanadium coatings on 25-28 um HGMS, while a ten hour coating run with source-substrate distance at 3.5 inches resulted in 300 nm tungsten coatings on 32-38 um HGMS. Analysis of this data confirms that linear agitation and fine-tuning sputter coating parameters does support uniformity and ensures thick coatings of HGMS. While these are promising results, this system can only maintain high uniformity and thickness when coating small batches of HGMS at a time. Efforts to develop a larger system capable of producing much higher yield without comprising uniformity and thickness will be discussed.

2:00pm **PP1-2-MoA-2 Investigation of the Relationship Between Film Texture and Hydrogen Barrier Characteristics in HCD-IP ZrN Thin Films on Zircaloy-4***, **Cheng-Han Wu [Jordan91618@gmail.com]**, Kuan-Che Lan,* National Tsing Hua University, Taiwan

The mechanical integrity of Zircaloy-4 claddings, widely used in light-water reactors, is essential for maintaining structural reliability and preventing hydrogen-induced degradation. To mitigate hydrogen ingress, protective zirconium nitride (ZrN) coatings were deposited on Zircaloy-4 substrates using a hollow cathode discharge-ion plating (HCD-IP) system. This study aims to explore how crystallographic texture may affect the hydrogen barrier characteristics of the ZrN films. By adjusting the oxygen flow ratio during deposition, distinct texture evolution from (111) to (200) orientations was achieved. SEM and FIB will focus on the surface morphology and hydride layer formation, while XRD and GIXRD will be employed for phase identification, grain size estimation, and residual stress evaluation. EPMA and XPS measurement will include the nitrogen-plus-oxygen-to-zirconium ratio (N+O/Zr ratio) and depth profile analysis to clarify the compositional variation with oxygen addition. The potential relationship between preferred orientation and hydrogen resistance will be investigated to discuss whether texture control in HCD-IP deposition plays a role in the hydrogen barrier characteristics of ZrN coatings.

2:20pm **PP1-2-MoA-3 Spherical Tungsten Coating as Inertial Fusion Targets***, **Ali Basaran [ali.basaran@ga.com]**, Priya Raman, Pavel Lapa, Ruben Santana, Hongwei Xu, Wendi Sweet, Fred Elsner, carlos monton,* General Atomics, USA*; Sasikumar Palaniyappan, Eric Loomis,* Los Alamos National Laboratory, USA

High density uniform tungsten coating on microscale spherical shells is of great interest for next generation inertial fusion energy targets since high-z shells are proposed to improve ablator performance and resistance to preheating. In this work, we present deposition of tungsten films on polymeric shells using direct current magnetron sputtering. Spherical shells are agitated on a pan to ensure uniform coverage during deposition. Delamination of high-z metals from the pan during thick coatings and agitation patterns that determine the surface finish of shells are addressed through several strategies. Process parameters such as pressure, power, and target-substrate geometry are optimized to achieve dense coatings with thicknesses up to 50 µm while minimizing residual stress, roughness, and porosity. Metrology of the shells such as thickness, sphericity, and roughness are quantified via x-ray, optical, and electron microscopy techniques. The influence of deposition conditions on coating microstructure and surface morphology will be discussed.

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