Surface Engineering - Applied Research and Industrial Applications
Room On Demand - Session G5
Hybrid Systems, Processes and Coatings

G5-1 INVITED TALK: Frontiers of Surface Engineering for Ultra-low Friction and Wear*, Ali Erdemir (erdemir8184@gmail.com)*, Texas A&M University, USA **INVITED**

In recent years, great strides have been made in the design and synthesis of new materials and coatings (such as atomically thin graphene, MoS_2, HBN, etc. and diamondlike carbons) affording friction coefficients as low as 0.001. When considering the fact that friction and wear related energy losses account for nearly a quarter of the global energy output at these days, the further development and uses of such materials will help in achieving a sustainable energy future that is also environmentally sensible. In this presentation, a comprehensive overview of what makes and breaks super-low friction in such materials is provided in relation to the many intrinsic and extrinsic factors acting on them and on sliding interfaces. In light of the recent analytical, experimental, and computational advances, an attempt will also be made to elucidate those underlying mechanisms that are most responsible for such ultra-low friction and wear behaviors. Several case studies involving monolithic and hybrid coating systems providing super-low friction and wear are also presented as the most exciting developments in tribological field. Overall, these and other novel approaches are leading the way for the design and production of next generation tribological systems that can dramatically increase efficiency, reduce carbon emission, as well as improve reliability in future moving mechanical systems.

G5-3 From *On-line* Sensor Validation to *in-situ* Monitoring of Layer Growth: Coatings around Fiber-Bragg-Gratings*, Uwe Beck (uwe.beck@bam.de), A. Mitzkus, M. Sahre, T. Lange, M. Weise, M. Bartholmai, V. Schukar, F. Basedau, D. Hofmann, E. Köppe,* BAM Berlin, Germany

The lack of *on-line* validation procedures for structure-embedded fiber-optical strain sensors, in particular fiber-Bragg-gratings (FBG), resulted in limited applications in structural health monitoring (SHM). Degradation under service conditions and ageing as a result of climatic influences or delamination under load were unsolved validation issues. This could be overcome by means of an auto-diagnosis procedure based on FBG-sensors coated by electrochemical deposition (ECD) with a magnetostrictive NiFe-coating on top of an adhesive Cu/Cr adhesive layer deposited by physical vapour deposition (PVD) around the FBG strain sensor. This allows at any time under service a validation of sensor functionality, stability, and reliability. For this purpose, a magnetic strain-proportional reference field is introduced. The optical read-out is realized by the measurement of the Bragg-wavelength shift. The ratio of resulting strain and exciting magnetic reference field should be constant given that the sensor is in proper function [1, 2, 3].

In principle, the magnetostrictive coating around the FBG should also work as *on-line* magnetic field sensor and other applications in material science. One of these applications is the *in-situ* monitoring of ECD processes as the deposition of the ECD NiFe-layer on the FBG revealed. Challenges are the monitoring of temperature, deposition stages/thickness, and resulting mechanical stress under given plating conditions. Monitoring problems can be solved by applying a pre-coated FBG to the electrolytic process as the shift of the Bragg wavelength is affected by both the temperature of the electrolyte near the substrate and the stress formation in the growing layer. The experimental FBG set-up and the quantitative determination of temperature- and stress-related strain are described for a nickel-iron electrolyte. The in-situ measurement of Bragg wavelength shifts of a pre-coated FBG during electrochemical deposition allows a detailed analysis of stress states due to changes in the growth morphology of the layer. The separation of mechanical and thermal contributions to this shift provides information on the individual deposition processes in terms of a process fingerprint [4].

[1, 2, 3] DFG projects SCHU 2707/2-1, BA 5015/1-1, BE 3206/2-1.

[4] A. Mitzkus, M. Sahre, F. Basedau, D. Hofmann, and U. Beck; Journal of The ECS, 166 (6) B312-B315 (2019)

G5-4 Characterization of the Combination of Microwave and Laser Ablation Plasmas*, Enrique Camps (enrique.camps@inin.gob.mx), E. Campos-Gonzalez,* Instituto Nacional de Investigaciones Nucleares, Mexico

The main aim of the present work is to report on the study of the combination of continuous plasma, formed by a microwave electron cyclotron resonance (ECR) discharge and pulsed plasma of laser ablation which allow studying the formation of materials in the form of thin films making use of the relatively high densities of the microwave discharge and the wide range of ion energies produced in the pulsed laser ablation plasmas. With this arrangement it is possible to deposit thin films of materials that in the usual microwave discharge require the use of pollutant and corrosive substances, as the required element is obtained from a pure solid target. Moreover, as the laser ablation process is carried out in plasma as the background gas, instead of a neutral gas, the presence of contaminants, such as oxygen can be significantly reduced. For the purpose of the present paper a nitrogen microwave ECR discharge was combined with the plasma created during the ablation of an aluminum target, in order to deposit AlN thin films. Plasma parameters were measured by a Langmuir probe, and the chemical species contained in the plasma were analyzed by optical emission spectroscopy (OES).

G5-6 Thermal Stability of Passivated Oxygen Vacancy in Indium Gallium Zinc Oxide with Supercritical Fluid Cosolvent Oxidation, Post Annealing or Oxygen Plasma Treatment*, Chia-Yu Lin (mandylin21107@gmail.com), P. Liu,* National Chiao Tung University, Taiwan*; D. Ruan,* National Chiao Tung University, China*; Y. Chiu, K. Gan, C. Hsu,* National Chiao Tung University, Taiwan*; S. Sze,* National Chiao Tung University, USA

In this report, the thermal stability of oxygen vacancy in indium gallium zinc oxide (IGZO), which was passivated by supercritical fluid (SCF) cosolvent oxidation, post annealing or oxygen plasma treatment, has been investigated in detail. With X-ray photoelectron spectroscopy (XPS) analysis, it can be found out that the oxygen vacancy passivated by SCF treatment exhibits better thermal stability than other oxidation treatment. Besides, the IGZO treated with different treatment has been used as the channel material for thin thin-film transistor device. Similar with the XPS result, the device with SCF treatment shows excellent reliability and uniformity even within high temperature ambient.

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