Advanced Surface Engineering
Room Ballroom A - Session SE-ThP

Advanced Surface Engineering Poster Session

SE-ThP-1 PLD or Magnetron Sputtering: Which to Choose for Functional Coatings?, ***Esteban Broitman***, *Sven Kelling, Rickmer Kose,* SENTYS

This review evaluates pulsed–laser deposition (PLD) and magnetron sputtering (MS) through a practical, application–oriented lens to help researchers and engineers select the most appropriate route for functional thin films (oxides, nitrides, chalcogenides, carbon-based). Drawing on head–to–head studies that deposit identical materials with both techniques, the paper traces how differences in deposition physics translate into film composition, microstructure, defect populations, mechanical properties and device performance.

PLD is highlighted for its reliable stoichiometric transfer from complex targets, its ability to produce high bonding density and elevated sp^3 fractions in carbon films, and its suitability for epitaxial growth and high–hardness coatings; its principal drawback is the tendency to generate particulates from the energetic plume unless droplet–mitigation strategies are employed. Magnetron sputtering (DC/RF) is shown to excel at large–area uniformity, conformal coverage and low macroscopic droplet density; pulsed modes and HiPIMS further boost ionization and substrate bombardment, yielding dense films that can rival PLD in many functional metrics while offering established industrial throughput.

The review also surveys hybrid PLD+MS approaches that leverage PLD's compositional fidelity together with sputtering's smoother deposition to reduce defects and increase density. Advances in ultra–high vacuum (UHV) platforms enhance both methods: UHV PLD improves cleanliness and epitaxial control, and UHV MS reduces impurity uptake and tightens reproducibility. Manufacturers of scientific research equipment such as **PREVAC** exemplify systems that enable in–situ diagnostics and clean sample transfer. Finally, the paper places cost and scalability in context: bench–scale sputter tools are typically less costly to acquire and run than PLD benches, whereas at production scale capital expenditures for high–end HiPIMS sputter systems and wafer–scale PLD platforms converge.

The review closes with a concise decision matrix and actionable guidelines to match deposition choice to stoichiometry, surface quality, throughput and budget constraints.

SE-ThP-5 Synthesis and Dehydrogenation of Thin Film Metal Hydride for Hydrogen Storage, *Vladimir Gorokhovsky,* ***Grace Owens***, University of Colorado at Boulder; *Paul Smith,* Plasma Kinetics Corporation

Magnesium hydride (MgH_2) is solid-state hydrogen storage material, with a theoretical hydrogen storage capacity of 7.6 wt%, making it an attractive candidate due to its high hydrogen affinity, low cost and abundance. But high enthalpy of formation and high decomposition energy of MgH_2 requiring about 76 kJ/mol of heat for each mole of H_2 released lead to increase of hydrogenation temperature, slow hydrogenation and dehydrogenation kinetics. Ni is often used as a catalyst to improve the kinetics of MgH_2 formation in H_2-contained atmosphere due to reduced enthalpy of formation of Mg-Ni alloys (<65 kJ/mol) and also has a reduced activation energy of dissociation of molecular hydrogen in comparison to Mg, suggesting that Ni mainly catalyzes the dissociation/recombination reaction barrier for H_2 solid-state hydrogen storage material reducing the hydrogenation/dehydrogenation temperatures. MgNi thin film coatings were prepared via vacuum cathodic arc deposition on sapphire wafer, aluminum foil, and aluminized polyamide tape. The cathodic arc process conditions for deposition of MgNi coatings were chosen to keep the substrate temperature low for which the arc current was selected from 50 to 70 A, and substrates (both sapphire and metal foil) were installed in a free-standing position at floating potential. The coating architecture consisted of the bottom supporting NiTiCu sublayer having large open columnar microstructure promotes the formation of the columnar microstructure with open voids in the MgNi layer. The Pd top layer deposited by e-beam evaporation improves hydrogen absorbance capability. The films were hydrogenated in Ar/5%H_2 atmosphere at 300°C in atmospheric pressure. The hydrogenation changed the color of the coating surface from silver metal to dark color accompanied by reduced electrical conductivity and increased transparency of the film indicating shift from metallic to insulative ceramic The dehydrogenation of the magnesium hydride containing films was made via laser irradiation at room temperature using 808 nm wavelength CW laser. The hydrogen flow, consisting of both molecular and atomic hydrogen, generated by laser irradiation of one hydrogenated coating spot 1mm x 10mm during 1s ranging from 0.5 to 1 SCCM. It was demonstrated that almost 90% of hydrogen contained in hydrogenated NiTiCu/MgNi/Pd coating can be released by CW laser irradiation from the 1" x 1.25" sample. The partial light transparency and increased light absorbance of MgH_2 improved by columnar microstructure with open voids provide a basis for using amplified light beam to release hydrogen from the thin film, contributing to safe and efficient hydrogen storage.

SE-ThP-6 Photodegradable Thin Films for Dust Mitigation, ***Kira Sand***[1], *David Allred,* Brigham Young University

High-contrast optical systems for space applications require effective dust mitigation strategies to maintain low-scatter surfaces and edges. A novel approach would be to use photodegradable thin films that can remove any dust particles after launch, thereby reducing the likelihood of further particulate accumulation.

In this work, we investigate the photodegradation behavior of polymers such as poly(olefin sulfone) (PMPS) and poly(1-hexene sulfone) (PHS) under space-like conditions, specifically in vacuum under UVC irradiation (254 nm and 172 nm). We demonstrate that these materials undergo efficient dissociative degradation, enabling the removal of dust from coated optical surfaces. Our results show a significant reduction in particle coverage following irradiation of dust-coated films.

Additionally, we report the use of more energetic thin-film materials, including ammonium nitrate, which exhibit similar photodegradation behavior. These materials may provide enhanced dust removal efficiency due to the higher energy stored in their chemical bonds.

Overall, this study highlights the potential of photodegradable thin films as an effective strategy for in situ dust mitigation in space-based optical systems.

SE-ThP-9 Heterointerface-Induced Charge Transfer Kinetics in Sputtered $Mote_2$-Mos_2 Nanocomposite for High-Performance Ambient No_2 Detection, *Sonika Kodan,* ***Ramesh Chandra***, Indian Institute of Technology Roorkee, India

The present research reports a nanostructured $MoTe_2$-MoS_2 n-n heterojunction-based gas sensor developed on a silicon (Si) substrate, demonstrating room-temperature (RT, 30 °C) nitrogen dioxide (NO_2) sensing. A controlled and one-step magnetron co-sputtering approach is utilized to deposit $MoTe_2$-MoS_2 nanocomposite thin film on a Si substrate, producing a uniform, dense, and porous nanoscale morphology. Herein, surface analysis and structural characterization of the $MoTe_2$-MoS_2/Si sensor reveal a rough, and defect-rich morphology with abundant exposed edge sites, which significantly enhances the availability of active adsorption sites for effective gas sensing. The developed $MoTe_2$-MoS_2/Si heterostructured sensor delivers an exceptional sensor response of 74.4% with an ultrafast response/recovery time of 7.5/2 s towards 25 ppm NO_2 at RT. Additionally, the present sensor showcases highly reproducible and consistent behavior over a wide range of NO_2 concentrations (1-60 ppm), along with remarkable selectivity against common potential interfering gases (H_2S, NH_3, CO, H_2) and a low detection limit of 700 ppb. This study provides critical insights into NO_2 sensing induced by heterointerface band modulation and defect-assisted adsorption at the sensor's surface, thereby providing a strong foundation for a reliable platform for high-performance NO_2 gas sensors based on the MoTe2-MoS2 heterostructure.

[1] **JVST Highlighted Poster**

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