Advanced Surface Engineering
Room 304 - Session SE-ThA

Advanced Surface Engineering Oral Session

Moderators: Prof. Dr. Diana Berman, University of North Texas, **Prof. Dr. Filippo Mangolini**, The University of Texas at Austin

2:15pm **SE-ThA-1 In-Situ Raman Spectroscopy of Adaptive Tribological Coatings**, ***Andrey Voevodin***, University of North Texas **INVITED**

In-situ Raman spectroscopy is a powerful method to investigate adaptive tribological surfaces. The in-situ Raman spectroscopy is shown to capture tribologically induced changes of adaptive coatings inside the lubricated sliding contact in response to applied mechanical and thermal stresses. For solid lubricated adaptive contacts, duplex plasma-electrolytic oxidation (PEO) and chameleon coating produced on Al alloys were investigated. These were composed of a 80-160 mm thick hard load-supporting Al-Si-O coating and a 5–8 µm top layer of a chameleon coating made of graphite or BN, MoS_2 or WS_2, and Sb_2O_3. For liquid contacts, 52100 steel coupons were tested under lubricant starvation regimes using low viscosity hydrocarbons. The counterpart pins were made of 52100 steel and Si_3N_4. The tests were performed at temperatures ranging from room (liquid lubrication) to 600 °C (solid lubrication). In-situ Raman spectroscopy revealed that the lubricating phases, i.e. MoS_2, WS_2, and graphite, were protected from oxidation by the porous PEO structure. It also revealed a gradual evolution of chameleon composition with diminishing orthorhombic Sb_2O_3 phase presence at the surface in favor of hexagonal lubricating phases of chameleon components. The low shear strength of MoS_2, WS_2, and graphite and the integration of the chameleon coating with the PEO sublayer were responsible for the ultra-low friction behavior. In all examples, the in-situ Raman spectroscopy was shown to reliably detect contact chemical change correlated with the observed friction behavior.

2:45pm **SE-ThA-3 Automated Characterization of Combinatorial Thin Films and Their Stress**, ***David Adams***, *Finley Haines, Amun Jarzembski,* Sandia National Laboratories, USA

Combinatorial sputter deposition techniques provide an ability to fabricate a large variety of thin films in a relatively short time thereby accelerating materials discovery. Indeed, past studies have reported methods that produce 10s or 100s of unique films in a single vacuum deposition. Despite these advances, new, high-throughput characterization techniques are needed to match the pace of combinatorial synthesis. In particular, automated techniques that accurately reveal the structure and the relevant properties of combinatorial films are of great interest.

Toward this end, we describe automated, ex-situ characterization of biaxial film stress wherein >100 individual, combinatorial thin films are probed in concert. Combinatorial, magnetron sputter-deposited Pt-Au and Pt-Ni films are interrogated using a k-Space Co. Thermal Scan instrument wherein samples are affixed inside a vacuum test cell. This instrument precisely moves a laser spot array to each specimen (before and after deposition) to determine wafer curvature changes. The application of Stoney's equation to determine the stress of combinatorial films from measured curvatures is discussed. Films are much thinner than the substrates (which satisfies one Stoney assumption), but a laterally graded thickness across each specimen moves away from at least one separate assumption used in the derivation of this often-used equation. Accounting for measured thickness gradients, we demonstrate accurate stress measurements over a range of temperatures up to +600C. Combinatorial Pt-Au and Pt-Ni films produced in single depositions exhibit a variety of stress responses that are ultimately correlated to measured film density and composition. Altogether, we determine their thermal expansion coefficients, pinpoint their onset of relaxation, and reveal changes occurring at high temperature tied to secondary phase formation. The gathered information augments an extensive library of process-structure-property relationships that underly their high-temperature performance.

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3:00pm **SE-ThA-4 Designing Defect Structure and Interfacial Strain in an Epitaxial VN Bilayer Film by Tailoring N Concentration**, ***Marcus Hans***, *Damian Holzapfel,* RWTH Aachen University, Germany; *Zhuo Chen,* Erich Schmid Institute of Materials Science, Austria; *Soheil Karimi Aghda, Michal Fečík,* RWTH Aachen University, Germany; *Daniel Primetzhofer,* Uppsala University, Sweden; *Zaoli Zhang,* Erich Schmid Institute of Materials Science, Austria; *Jochen Schneider,* RWTH Aachen University, Germany

A bilayer of $V_{0.49}N_{0.51}/V_{0.56}N_{0.44}$ has been grown epitaxially on MgO(001) by reactive high power pulsed magnetron sputtering in an industrial-scale deposition system at a temperature of 400 °C and it is demonstrated that the defect structure and interfacial strain are governed by the N concentration. Based on the lattice mismatch between MgO and $V_{0.49}N_{0.51}$ with V vacancies, an interfacial strain of -2.3(1)% is expected. From ab initio calculations, X-ray diffraction and transmission electron microscopy data it is inferred, that the $V_{0.49}N_{0.51}$ layer exhibits V vacancies, N Frenkel pairs and a high dislocation density of ~0.20 nm^{-2}, causing an interfacial strain of -1.4(5)% at the $MgO/V_{0.49}N_{0.51}$ interface. The phase formation of understoichiometric $V_{0.56}N_{0.44}$ is governed by N vacancy formation, while the dislocation density is reduced to ~0.04 nm^{-2} at the $V_{0.49}N_{0.51}/V_{0.56}N_{0.44}$ interface and to < 0.01 nm^{-2} within $V_{0.56}N_{0.44}$ at a distance of ~35 nm from the interface. Based on ab initio calculations, a strain of -1.7(6)% is predicted at the $V_{0.49}N_{0.51}/V_{0.56}N_{0.44}$ interface in very good agreement with the experimentally obtained value of -1.6(8)%. It is evident that control of the N concentration allows for the design of layered architectures with well-defined strained interfaces and tailored defect structures. Finally, the employment of only one transition metal is chemically simple and therefore, from a recycling point of view, also more sustainable than combining different transition metals as commonly done in layered architectures, including superlattices.

3:15pm **SE-ThA-5 Corrosion Behaviour of Zr-Ti-N Thin Films**, ***Jyoti Menghani***, Sardar Vallabhbhai National Institute of Technology SURAT, India; *k Baba Pai,* ITM UNIVERSE, India; *Nitin Jalgaonkar,* Seco Tools ,India

Zr–Ti–N coatings with varying thicknesses (1.5, 2.0, 2.5, and 3.0 µm) were deposited on 316 stainless steel substrates by cathodic arc evaporation using separate zirconium and titanium targets in a reactive nitrogen atmosphere. The influence of coating thickness on the microstructure and corrosion behavior of the films was systematically investigated. X-ray diffraction (XRD) analysis revealed the formation of crystalline Zr–Ti–N phases along with the presence of substoichiometric Ti_2N.

Surface and cross-sectional morphologies of the coatings were examined using scanning electron microscopy (SEM), which confirmed dense columnar growth of the deposited films. Cathodic arc-induced droplets were observed on the coating surfaces, and their presence was found to influence surface morphology and localized corrosion characteristics. Variations in coating thickness significantly affected coating compactness, defect density, and structural integrity.

The corrosion behavior of the coatings was evaluated in 0.1 N HCl solution using potentiodynamic polarization and electrochemical impedance spectroscopy (EIS). The acidic HCl medium was selected to simulate aggressive industrial corrosive environments. Electrochemical studies demonstrated that the corrosion resistance of the coatings improved with increasing coating thickness. The corrosion current density (Icorr) decreased from 136 µA/cm^2 for 1.5 µm Zr–Ti–N coating to 92.14 µA/cm^2 for 3.0 µm coating, indicating enhanced barrier protection and reduced electrolyte penetration. EIS results further confirmed the improvement in charge transfer resistance and protective efficiency with increasing coating thickness.

The study demonstrates that coating thickness, microstructural evolution, and cathodic arc droplet formation play a significant role in determining the corrosion performance of cathodic arc deposited Zr–Ti–N coatings for protective applications in aggressive acidic environments.

3:30pm **SE-ThA-6 High Throughput Thin Film Materials Synthesis via Laser Spike Annealing**, ***Drake Austin***, Air Force Research Laboratory (AFRL) **INVITED**

As the discovery of new materials and functionalities are occurring at an unprecedented rate, new strategies to accelerate the connection between material state or property to a desired application are necessary. Despite the availability of modern tools, the slow, tedious, and Edisonian research practices of the past are still the standard for areas such as thin films and coatings. The development of a new thin film requires either starting from a known, reported recipe, or the use intuition to determine a suitable starting condition. After thin film deposition is complete, there may be

post-growth optimization and characterization, with many iterations of this process necessary until the initial growth conditions match some desired end state.

Laser spike annealing (LSA) is a promising technique for rapidly investigating the modification of thin film materials due to thermal annealing. By scanning a focused, continuous-wave laser across a thin film surface, localized heating can be achieved with heating/quenching times as short as microseconds and temperatures exceeding 1000°C. The laser intensity, scan rate, and annealing environment can be varied, allowing thousands of distinct annealing conditions to be studied on a single sample, including dwell times several orders of magnitude shorter than what can be achieved with rapid thermal annealing. This approach can therefore be used for accelerated materials discovery and optimization by modifying existing thin films in a localized, high throughput manner.

In this work, LSA is applied to the oxidation of various thin film materials, including transition metals such as Hf and transition metal dichalcogenides such as MoS2. Tunable oxidation is achieved by varying the laser conditions in a controlled oxygen environment, enabling access to a wide range of effective temperatures and heating times. The resulting structural and compositional modifications are characterized using X-ray diffraction, Raman spectroscopy, ellipsometry, UV-vis absorption spectroscopy, and X-ray photoelectron spectroscopy. Applications in the study of optical and electronic materials are presented, including refractive index optimization and the development of materials for neuromorphic device applications.

4:00pm **SE-ThA-8 Towards Reliable X-Ray Photoelectron Spectroscopy: Understanding Fundamental Differences between Analyses Performed on Samples with and Without Electrical Contact to Spectrometer***, **Grzegorz (Greg) Greczynski,*** Linköping University, Department of Physics, Sweden

X-ray photoelectron spectroscopy (XPS) analyzes of insulators or inhomogeneous samples containing insulating phases are often done with specimens electrically isolated from ground and the surface potential controlled by the flood gun. While such approach offers the possibility of delivering non-distorted spectra, the consequences for the energy level alignment between sample and the spectrometer are often not considered. The present contribution highlights these aspects by discussing several, carefully selected, case studies that visualize fundamental differences between XPS analyses performed on samples with and without electrical contact to ground. Consequences for core level shifts, energy splitting between peaks from different samples, and spectra referencing are discussed in detail. It is shown that the choice of the measurement configuration (samples with *vs*. without contact to the spectrometer) determines to what extent binding energies of core level peaks from conducting and insulating samples (or conducting and insulating phases of the same sample) depend on the specimens' work function. Recognizing these aspects is crucial for the correct spectra referencing and interpretation of core level shifts for series of samples with varying work function.

4:15pm **SE-ThA-9 Lithography-Free Fabrication of Transparent, Durable Glass Surfaces with Embedded Functional Nanostructures***, **Iliyan Karadzhov,*** *Rubaiya Hussain, Alessia Mezzadrelli,* ICFO-Institut de Ciencies Fotoniques, Spain*; Wageesha Senaratne, Prantik Mazumder,* Corning Research and Development Corporation*; Valerio Pruneri,* ICFO-Institut de Ciencies Fotoniques, Spain

Glass is central to displays, touchscreens, medical interfaces, and public interactive systems. Integrating additional functions such as antimicrobial activity and mechanical durability to optical clarity is of significant commercial interest which, however, remains challenging. Lithographic techniques provide excellent control over nanoscale geometry and are widely used for surface patterning. However, for applications where random subwavelength features are acceptable, lithography-free routes based on self-assembled metal masks can reduce process complexity and improve compatibility with large-area glass processing.

Among candidate antimicrobial materials, Cu offers well-established ion-mediated antibacterial activity; however, exposed Cu nanostructures are susceptible to wear and optical degradation, limiting their practical use on transparent surfaces. Embedding Cu within glass nanostructures is therefore an attractive strategy to simultaneously enable durability and sustained functionality. In our previous work on abrasion-resistant antireflective glass, thermally dewetted Ag nanoparticles were used to form a Ni nanohole mask for dry etching subwavelength nanoholes into glass. While effective for creating durable antireflective textures, this approach was not suitable for embedding Cu because a selective etchant that could remove the Ni mask without attacking or degrading the embedded Cu could not be identified.

We overcome this limitation by replacing the Ni hard mask with a diluted polymer nanohole mask, enabling wet glass etching and subsequent lift-off of Ti/Cu nanodisks embedded below the glass surface. The resulting surfaces show 80–85% visible transmission, haze below 1%, and near-neutral color. Antimicrobial testing against *E. coli* OP50 shows approximately 99% bacterial reduction after 1 h, while crockmeter abrasion causes no measurable optical change. Future work will optimize geometry and Cu release to improve antimicrobial efficacy toward sanitizer-level benchmarks and validate performance against standard test strains.

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-2 Surface Engineering of Ni-Based Alloy Thin-Film Catalysts for Enhanced Hydrogen Evolution Reaction, *Zhe-Yu Liu, Jhih-Siang Yang, Fan-Bean Wu,* ***Wan-Yu Wu***, National United University, Taiwan

Nickel-based thin-film catalysts have attracted increasing interest as cost-effective alternatives to noble-metal electrocatalysts for water electrolysis. In this study, Ni-Cu and Ni-Mo alloy thin films were prepared by magnetron co-sputtering as a surface engineering strategy to tune composition, morphology, and electrocatalytic performance for the hydrogen evolution reaction (HER). The sputtering process enables the fabrication of dense, adherent, and composition-controlled thin films, providing a useful platform for clarifying the relationship between alloy composition and catalytic activity.For the Ni-Cu system, Cu was incorporated into Ni to balance hydrogen adsorption behavior and improve charge-transfer properties. Pure Ni tends to bind hydrogen too strongly, whereas Cu has weaker hydrogen adsorption and high electrical conductivity. Therefore, the Ni-Cu alloy design is expected to provide a synergistic effect for HER. Electrochemical measurements in 1 M KOH showed that the Ni-Cu thin film with a near-equiatomic composition of approximately Ni:Cu = 55:45 exhibited the best HER performance, achieving overpotentials of 76 mV at 10 mA cm^{-2} and 180 mV at 100 mA cm^{-2}. This film also showed the lowest charge-transfer resistance of 0.71 Ω, indicating enhanced interfacial reaction kinetics.For the Ni-Mo system, Mo-Ni alloy thin films with different Ni contents were deposited by DC co-sputtering on silicon and carbon-paper substrates. Structural and surface analyses indicated that co-sputtering promoted composition-dependent thin-film structures with hydrophilic surfaces. In 0.5 M H_2SO_4, the Mo-Ni catalysts exhibited a volcano-type dependence of HER activity on Ni content. The catalyst with 72.8 at% Ni showed the optimal performance, with an overpotential of 149.0 mV at 10 mA cm^{-2} and a Tafel slope of 77.5 mV dec^{-1}. In 1 M KOH, HER activity generally improved with increasing Ni content, suggesting the important role of Ni in alkaline HER kinetics.Overall, these results demonstrate that magnetron co-sputtering is an effective approach for tailoring the composition and surface properties of Ni-based alloy thin-film catalysts. The Ni-Cu system highlights the importance of balancing hydrogen adsorption and charge transfer, while the Ni-Mo system shows that composition-dependent structural modification strongly influences HER kinetics.

SE-ThP-3 Mechanochemically-Driven Formation of Zero-Friction and Zero-Wear Lubricating Carbon Films, ***Diana Berman,*** University of North Texas

Mechanically-induced surface degradation creates a significant problem for currently-used mechanical assemblies and is the major cause for their loss of usefulness. Meanwhile, high-contact pressure and shear during relative movement of the sliding interfaces provide the unique capability for local heating and shear- and load-induced compression of the sliding surfaces. For a correct combination of materials in sliding contact, these conditions may induce tribochemical reactions that lead to the formation of a protective damage-suppressing tribofilm directly at the contact. In this presentation, we overview recent advances in establishing the fundamental understanding of materials interactions at sliding interfaces and use this knowledge as a guide to developing nanomaterials solutions that enhance reliability and efficiency of tribological systems. We demonstrate tribochemically-driven self-replenishment of materials inside the contact interfaces, thus enabling a zero-wear sliding regime.

Overall, the findings could open a new avenue for the development of new concepts and design strategies for next generation of tribologically efficient materials systems.

SE-ThP-4 Friction and Wear of Composite MXene/MoS_2 Coating Under Low-Viscosity Fuels, ***Ali Zayaan Macknojia***, *Diana Berman, Andrey Voevodin, Samir Aouadi,* University of North Texas*; Stephen Berkebile,* Army Research Laboratory

Friction and wear-related failures remain major challenges in moving mechanical assemblies operating under various conditions. For example, the components of fuel systems made of AISI 52100 steel are susceptible to scuffing-induced wear when operated in a fuel environment. This study demonstrates the decreased friction and wear characteristics achieved by spray-coating 52100-grade steel surfaces with solution-processed multilayer Ti_3C_2Tx-MoS_2 blends. The study analyzed the performance of the coating under high contact stresses and sliding speeds in different fuels. Raman spectroscopy, scanning electron microscopy, and transmission electron microscopy results revealed the formation of a robust in situ tribolayer responsible for the outstanding performance observed at high contact pressures and sliding speeds. This study has broad implications for the development of solid lubricants that can operate under extreme conditions and low-viscosity fuel environments, inspiring further research and development in this field.

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***, *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-7 Surface Patterning with Unconventional Self-Assemblies by an *m*-Terphenyl Isocyanide Ligand, ***Liya Bi***, *Zhiyuan Yin, Krista Balto, Joshua Figueroa, Shaowei Li,* University of California San Diego

Self-assembled monolayers (SAMs) refer to spontaneously formed single-layer molecular sheets on surfaces, which have found applications in corrosion protection, catalysis, drug delivery, molecular sensing, etc. The assembling behaviors of a given molecule on the surface depend on both the molecule-surface interactions and the intermolecular interactions which include covalent bonding, van der Waals interaction, hydrogen bonding or a combination of these forces. Consequently, there are various tuning knobs towards controllable molecular self-assemblies by modifying either the surfaces or the molecules. Here, we report the unconventional self-assembled patterns of a rationally designed *m*-terphenyl isocyanide ligand, $CNAr^{Mes2}$, on Ag surfaces. This molecular ligand binds to metal atoms via its isocyanide group and experiences rich intermolecular interactions upon surface adsorption because of its *m*-terphenyl skeleton. We anticipated it to form a dimerized linear molecular chain on metal surfaces based on its profile, as confirmed on Cu(100) and Cu(111) surface. Surprisingly, $CNAr^{Mes2}$ self-assembles into a few unexpected structures on Ag(111) surface including ribbons, rings and hexagons at low surface coverage and forms closely packed monolayers at high molecule density. A detailed study on these unconventional patterns suggests that $CNAr^{Mes2}$ trimer other than the dimer is the building block and that the surface chemistry of Ag plays a vital role in this assembling mechanism change. These observations inspire us to engineer the metal-binding isocyanide group and/or the steric bulks of $CNAr^{Mes2}$ to achieve programmed SAMs with on-demand shapes, lattice constants and functionalities on metal surfaces.

SE-ThP-8 ASSD Student Award Finalist Poster: In-Situ Tribo-Sintering and Atomic Structure of 2D Silicate Interfacial Films derived from Sustainable Oleogels, ***Mohammad Eskandari***, *Diana Berman, Ali Zayaan Macknojia,* University of North Texas

Designing stimuli-responsive interfacial materials capable of adapting to extreme thermomechanical stresses remains a profound challenge in surface science. Conventional liquid lubricants typically exhibit catastrophic boundary film failure at elevated temperatures. Here, we report a paradoxical friction-reversing phenomenon in sustainable bio-oleogels thickened with organically modified montmorillonite nanoclay: an autonomous transition to a macroscopic superlubricity regime (COF <0.01) initiated solely by high contact pressures (500 N) and thermal activation (150°C).

To unravel the structural mechanisms underlying the observed superlubricity phenomena, we first performed a post-tribology Raman spectroscopy analysis that confirmed the formation of a clay-based tribofilm. The 3D topographical maps acquired with ultra-high-resolution confocal laser scanning microscopy (~140 nm) confirmed the contiguous nature of it. Electron diffraction and lattice fringe imaging using high-resolution transmission electron microscopy (HR-XTEM) revealed the in-situ self-assembly of ordered layers, sintered at the plastically deformed metallic asperities. Through the combined multi-scale microscopy approach, this research provides direct evidence of a shear-induced sol-to-solid phase transition at the sliding interfaces, revealing a new class of intelligent, bio-derived, adaptive liquid interfaces for extreme environments.

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