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Editorial

Surface Innovations

Editorial

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In this third issue of 2025, we feature six original research reports on the following topics: development of a new class of MXene-based surface-enhanced Raman scattering substrate,[1] sunlight resistance of dyed polysulfonamide fabrics,[2] wetting of indium on nickel-copper alloy,[3] tribological characteristics of a novel metal-organic framework,[4] wear- and corrosion-resistance of iron-based coating in a biodiesel medium,[5] and fretting performance of TiN/diamond-like-carbon duplex coating.[6]

Surface-enhanced Raman scattering (SERS) is an effective analytical technique used for detecting molecular species, recognized for its rapid detection, high sensitivity, and strong specificity. It has garnered significant research interest globally over the years. Nowadays, SERS materials are frequently paired with flexible substrates, which are ideal for detecting irregular surfaces and provide excellent portability and durability. In a Feature Article, Tang *et al.*[1] describe the fabrication and characterization of a novel class of MXene-based SERS substrates. MXenes are a family of two-dimensional materials composed of transition metal carbides, nitrides, and carbonitrides. They are known for their high electrical conductivity, hydrophilicity, and have potential applications in energy storage, water treatment, and other fields. The authors developed a flexible SERS substrate using MXene and aligned silver (Ag) nanowires (NWs) decorated with silver nanoparticles (NPs). Their findings demonstrate that the combination of MXene and aligned Ag NWs, along with the Ag NPs, synergistically enhances the Raman activity of polydimethylsiloxane substrates. These new substrates exhibit high sensitivity, excellent reproducibility, and good flexibility and stability in SERS applications. This innovation is significant for flexible SERS sensors and provides valuable insights into MXene-based metallic optical materials.

With growing demand for durable technical textiles, understanding the sunlight resistance of natural and synthetic fibers is crucial. In the second contribution to this issue, an interdisciplinary team of researchers explores the sunlight resistance of dyed polysulfonamide (PSA) fabrics, emphasizing their photofading behavior, UV absorption efficiency, and mechanical degradation.[2] The study finds that PSA fabrics dyed with Disperse Blue 56 demonstrate superior UV absorption and stability compared to those dyed with Disperse Red 60 and Disperse Violet 26. Electron spin resonance analysis shows that Disperse Blue 56-dyed PSA fabrics have the highest concentration of free radicals, enhancing UV absorption efficiency. However, all dyed fabrics exhibited low light fastness, resulting in significant photofading. Mechanical testing reveals that PSA/Disperse Blue 56 fabrics maintain better breaking strength after UV exposure, correlating with their superior UV resistance. The research provides insights into UV-induced degradation mechanisms and highlights the importance of dye selection for improving sunlight resistance. Additionally, it proposes a high-temperature, high-pressure carrier dyeing method to enhance UV absorption, setting the stage for future dyeing optimizations.

Indium is gaining attention for thermal management due to its low melting point, high thermal conductivity, and ductility. As high-power density devices exceed 1000 W and 200 W/cm^2, traditional thermal interface materials often fail to meet the demands. Indium offers an ideal solution but requires optimal wettability for reflow soldering. In a new study, Wang *et al.*[3] examine indium's wetting behavior on nickel and nickel-copper (NiCu) alloy layers, commonly used as bonding materials. They electroplated NiCu layers with uniform thickness and smooth surfaces, and applied nano-thick coatings of copper (Cu), silver (Ag), and gold (Au) to enhance wettability. Wetting was tested at 200–300°C, revealing a high contact angle of 90° on NiCu, while indium showed enhanced wetting on Au-coated NiCu with a contact angle of 24°. Scanning electron microscopy characterized the intermetallic compounds at the interface, demonstrating reactive wetting on NiCu and significant growth of intermetallics when coated with Au. This research contributes to improving heat dissipation in high-power density devices using indium.

Metal-organic frameworks (MOFs) are promising lubricant additives due to their high surface area, customizable properties, and eco-friendliness. In the fourth contribution to this issue, Hao *et al.*[4] describe a synthesis of zeolitic imidazolate framework-8 (ZIF-8) nanoparticles (100 nm) and then formulation of a novel nanolubricant by combining nanoparticles with a hydrophobic ionic liquid (IL). Tribological experiments showed that the ZIF-8@IL additive, when mixed with 150 SN base oil, significantly enhanced lubrication performance, especially at a 4.0 wt.% concentration, resulting in a 27% reduction in the coefficient of friction and a 20% decrease in wear track width. This superior performance is linked to rolling, mending, polishing, and tribofilm formation, along with strong oxidative wear inhibition. These insights support the development of efficient MOFs-based nanolubricant additives.

Biodiesel, derived from plant or animal oils, is an eco-friendly energy source but faces limitations like auto-oxidation and moisture absorption, leading to corrosion and decreased wear resistance. In a new study, Ibrahim *et al*.[5] introduce a novel amorphous metal coating to improve wear and corrosion resistance in multigrade diesel engine oil mixed with 7% palm oil-based biodiesel. Using laser cladding at 40–60 mm/s with a constant laser power of 280 W for coating, microstructural analysis revealed an amorphous coating structure with a crystalline phase (FeCr). The coated specimens showed a 90% reduction in wear rate and corrosion rate decreases of 55–70%. These enhancements are attributed to reduced microstructural defects in the coating, suggesting that amorphous metal coatings can improve biodiesel reliability without additives that reduce combustion efficiency.

Hip replacement surgery is a procedure that involves replacing a damaged hip joint with artificial components. These implants aim to alleviate pain, enhance mobility, and restore normal function of the hip. However, a common issue that can lead to the failure of these implants is biocorrosion and wear at the interface of the metallic components, particularly at the taper junction, where wear and corrosion often occur. Khan *et al*.[6] propose the use of duplex coatings, specifically titanium nitride (TiN)/diamond-like carbon (DLC), to enhance the tribological performance of biomedical-grade stainless steel 316L, which is commonly used for femoral stems in total hip replacement implants. They applied a range of substrate pre-treatment methods to examine their effect on the mechanical and tribological performance of the coatings. The results indicate that unpolished substrates prior to coating deposition led to improved tribological performance, likely due to better adhesion of the coating to the substrate surface. Additionally, the hydrogenated DLC variants exhibited lower friction performance than the hydrogen-free DLC variants, which is likely attributed to higher levels of graphitization.

We welcome your feedback and suggestions to enhance the *Surface Innovations* journal for our readers in the future. We also invite thorough reviews and original research on surfaces, interfaces, coating science, engineering, manufacturing, and performance.

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