Advanced Surface Engineering
Room 303 - Session SE-WeA

Advanced Surface Engineering II

Moderators: Diana Berman, University of North Texas, **Jyh-Wei Lee**, Ming Chi University of Technology

4:15pm **SE-WeA-9 ASSD Student Award Finalist Presentation: In-Situ Tribo-Sintering and Atomic Structure of 2D Silicate Interfacial Films derived from Sustainable Oleogels**, ***Mohammad Eskandari*** [1], *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.

4:30pm **SE-WeA-10 Development and Characterization of $BaTiO_3$–GO reinforced PEEK Nanocomposites for High Temperature Functional Applications**, ***Unnati Joshi***, *Anand Joshi, Sushila Vadu,* Parul University, India

Polyether ether ketone (PEEK) has emerged as a high performance engineering thermoplastic due to its excellent mechanical strength, thermal stability, chemical resistance, and biocompatibility. However, its relatively low thermal conductivity and limited functional properties restrict its application in advanced electronic, aerospace, and tribological systems. In the present study, Barium Titanate ($BaTiO_3$) and Graphene Oxide (GO) reinforced PEEK nanocomposite was synthesized to investigate the synergistic influence of ceramic and carbon-based nanofillers on the thermal and microstructural characteristics of the polymer matrix.

The nanocomposite was prepared through Solution Processing and Homogenization of the nanomaterials, ensuring uniform dispersion of the reinforcing phases within the PEEK matrix.

Microstructural characterization was performed using scanning electron microscopy, which revealed a relatively homogeneous distribution of $BaTiO_3$ particles and GO powder with limited agglomeration. Energy-dispersive X-ray spectroscopy confirmed the presence and elemental distribution of Ba, Ti, C, and O within the composite structure, validating successful incorporation of the reinforcing phases. X-ray diffraction analysis identified the characteristic crystalline peaks of PEEK and $BaTiO_3$ while also indicating structural interactions between the fillers and matrix.

The thermal behaviour of the proposed nanocomposite was evaluated by STA from 25–1000 °C. The composite retained 98.6% and 95.4% mass at 300 and 500 °C, respectively, indicating excellent thermal stability. Major degradation occurred between 525–625 °C, with the maximum mass-loss rate at approximately 573 °C. The delayed degradation and substantial high-temperature residue are attributed to the synergistic thermal-barrier effects of GO and thermally stable $BaTiO_3$ reinforcements.

The combined thermal and structural analyses demonstrate that $BaTiO_3$–GO reinforced PEEK nanocomposites exhibit enhanced thermal performance and stable microstructural characteristics, making them promising candidates for multifunctional applications such as dielectric components, electronic packaging, aerospace structures, insulated bearings, and high temperature engineering systems.

4:45pm **SE-WeA-11 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.

[1] **ASSD Student Award Finalist**

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