TFC 2025 Topics with Descriptions
(2-07-25)

Topic 1: Tribology Challenges in Non-Terrestrial Environments

This session will review the tribological challenges of operating in Space. Humankind has ambitions to reach, and eventually colonize, the Moon and Mars. While extensive effort has been made to devise methods to safely reach and return from these destinations, they will require completely new technologies to survive and thrive in such hostile environments. One challenge will be how to safely operate, lubricate and repair machinery. Some of these issues have been addressed in connection with operating satellites in outer space, but planetary conditions will be sufficiently different from these to require novel solutions.

Topic 2: AI and Developing Machine-Learning Databases

This session will explore Artificial Intelligence and the creation of Machine-Learning Databases. Experimental results generally include the values generated by the experiment as well as the conditions used to obtain them, known as the metadata. Both of these are reported in journal articles and laboratory reports, but the reporting of the metadata can be variable. This issue particularly applies to tribological data where the results are extremely dependent on the sample and the conditions. This problem becomes particularly serious when these results are used for machine learning. A proposal has been made to standardize data presentation so that it is FAIR, that is it is of findable, accessible, interoperable, and reusable, which is particularly important for the future collection and standardization of tribological data. An associated tour will include the Argonne Computing Leadership Facility (ALCF), a Department of Energy Office of Science user facility, which houses Aurora, one of the world's first exascale supercomputers.

Topic 3: Experiments and Theory

This session will explore the critical interplay between experimental investigations and theoretical modeling in advancing the field of tribology. It will delve into cutting-edge research, examining how experimental data informs and validates theoretical predictions, while theoretical frameworks guide and optimize experimental design.

Topic 4: Nanomaterials in Tribology

This session will explore the transformative potential of nanomaterials in revolutionizing tribological performance across diverse applications. We will delve into the latest research

on the synthesis, characterization, and integration of nanomaterials such as nanoparticles, nanowires, and 2D-materials into advanced tribological systems.

Topic 5: Sustainability and Life Cycle Assessment

This session will cover topics of emerging issues and trends in tribological R&D related to sustainability. Including topics of energy savings and reduced greenhouse gas emissions; as well as the tools used to calculate these impacts through life cycle assessment.

Topic 6: Sensing Stresses by Mechanosensitive Molecules

This session will look at utilizing mechanosensitive molecules to sense stress. At the molecular level, there has been lots of work to study how forces can induce chemical reactions. Particularly relevant for the study of tribological interfaces are those reactions for which their physical properties such as light absorption or fluorescence depend on stress. Since molecules are generally small enough not to significantly perturb the tribological system, this approach offers an ideal tool for monitoring the state of surfaces or lubricant films in real time, both for fundamental studies and for condition monitoring of machinery.

Topic 7: Energy and Manufacturing

This session will cover the role of tribology and surface science in the applications of energy and manufacturing. This will include the surface material challenges faced by modern energy generation as well as the advanced materials manufacturing technologies that support these industries. The tour related to this topic will be the Materials Engineering Research Facility (MERF) – Argonne's facility for manufacturing process R&D and scale-up of new materials and validation of emerging manufacturing technologies.

Topic 8: Food Tribology

This session will delve into the fascinating and often overlooked field of food tribology, exploring the science of friction, wear, and lubrication as it relates to the processing, handling, and consumption of food.

Topic 9: Symposium on Tribochemistry: Shear-Induced Chemical Reactions at Sliding Interfaces

This symposium will explore the latest advancements in tribochemistry, emphasizing shear-induced chemical reactions that occur at contact interfaces under mechanical stress. Contributions from both experimental and computational perspectives are encouraged, particularly those that bridge the gap between the two. Key topics include the role of chemical bonding in adhesion, friction, and wear; friction-induced chemical reactions and their control; tribofilm formation and degradation; and the interplay between mechanical stress and interfacial chemistry. Additionally, discussions will cover multi-scale simulations, environmental influences on tribochemical processes, and nanoscale mechanisms of chemically-assisted wear.