EARLY CAREER POSTERS

Influences of Adsorbed Water on the Interfacial Tribological Phenomena in the Early Stage of Sliding

Z.A. Subhi, Malaysia-Japan International Institute of Technology, Kuala Lumpur, Malaysia

Surfaces are covered by adsorbed water layer due to ambient humidity. In the tribology of micro contacts, frictional and adhesive properties are sensitive to the adsorbed water because surface phenomena become more dominant than volumetric phenomena and therefore the influences of adsorbed water on adhesion become dominant. This study aimed to explore the mechanism of humidity changes to influence the adhesion by the observation of the tribological behaviour during the very early stage of sliding. In this study, a unidirectional ball-on-ball configuration tribo-contact simulator (T-CS) along with atmospheric humidity controller, were used to simulate the micro-sliding between two asperities. Results have suggested that the medium rate of relative humidity can be a critical condition for the tribo-contact due to the effect of liquid assisted adhesion. This critical condition is perhaps caused by the negative Laplace pressure of the meniscus bridge formed between the adsorbed water layer.

Molecular Dynamics Simulation of Drag Reduction by Nanobubble Clusters as Affected by Surface Morphology

Y. Lu, Wuhan University of Technology, Wuhan, China

The investigations of natural superhydrophobic surfaces of plants and animals showed that the wettability property is governed by the nanostructure characteristics of the surface. As a result of the improved surface hydrophobic by morphology, the trapping of gas is promoted on surface cavities to induce friction drag reduction, but gas cushion cannot stably exist. Nanoscopic gas bubbles that exhibit along lifetime and considerable stability may help improve the situation. In this study, molecular dynamics simulations are performed to analyze the formation behavior of nanobubble and the effect of nanobubble flow on the nanochannel with various surface morphologies. Results show that the existence of gaseous nanobubbles can be trapped by the surface cavities, which replace the dense and orderly absorbed liquid layer in non-bubble flow. Therefore, introducing surface morphology can further improve the effect on drag reduction.

Tribological Properties of Additive Manufactured Ti_6Al_4V Against Tungsten Carbide Under Dry Condition

X. Liang, Tsinghua University, Beijing, China

With the development of additive manufacturing (AM technology, titanium alloy manufactured by AM is widely used in aviation manufacturing. Although AM can achieve near net shape, the necessary machining is inevitable. In this paper, the tribological behaviors and wear mechanism of additive manufactured Ti_6Al_4V against tungsten carbide under dry friction condition are studied. The influence of normal load and temperature on friction coefficient were studied. The results show that the effect of load and temperature on friction coefficient is not obvious. We calculated the wear rate and found that the wear rate increased with the increase of load but decreased significantly with the increase of temperature. EDS analysis on the surface of the friction pair shows that tungsten oxide is generated on the friction surface at high temperature. Because tungsten oxide has lubrication properties, it reduces the wear rate at high temperature.

STUDENT POSTERS

Synergistic Effect of Combining TiO_2 and Montmorillonite Clay Nanoparticles as Lubricant Additives for Milling Processes

M.G. Flores, C.S. Rico, G.E. Gonzalez, Universidad de Monterrey, San Pedro Garza García, Mexico

In this work, nanoparticles of TiO_2 and montmorillonite clay were mixed with varying proportions and added to a cutting fluid for milling of an AISI 4340 steel. Due to its semi-spherical shape and small size nano TiO_2 fill surface valleys reducing friction; montmorillonite, being a multilayer flake-like nanomaterial may reduce friction and wear through exfoliation of their weakly-bonded layers. Laboratory experiments were performed in a four-ball tribotester to determine the best proportions of TiO_2 and montmorillonite clay that provided a synergistic effect. Milling experiments were performed in a CNC equipment with varying feed rate, depth of cut and cutting speed. Plates of AISI 4340 steel were milled with cutting inserts of cemented carbides. A Box Behnken experimental design was performed in order to optimize the milling input parameters and nanoparticle combinations that provided the lowest surface roughness of steel plates, spindle load and wear of cutting inserts.

Wear and Corrosion Performance of Friction Stir Spot Processed 316L Stainless Steel Deposited by High Deposition Rate Cold Spray Additive Manufacturing Process

P.R. Kalvala, M. Daroonparvar, M. Misra, A.M. Ralls, A.K. Kasar, P. Menezes, University of Nevada–Reno, Reno, NV

High Deposition Rate Cold Spray (HDR-CS) is a novel solid-state metal deposition process that uses the additive based principles from additive manufacturing (AM). By rapidly accelerating metal particles to a substrate, components can be prepared where the particles' intrinsic metallurgical properties are retained thus serving as an advantage over other AM-based technologies. Expanding CS to an industrial perspective, CS deposits act as an easy and effective method to repair various parts. This is especially true in marine-based industries where the combination of cyclic loading and corrosion can greatly diminish the surface material over time. However, the synergism between the wear and corrosion of CS 316L is not well studied. In this work, friction-stir processing (FSP) has been used to enhance the CS coatings' wear-corrosion resistance. The microstructural evolution and mechanical properties were then analyzed. The mechanisms for the improved wear-corrosion resistance are discussed.

The Effect of Axisymmetric Texture Floor Profile on the Lubricant Film Thickness of Textured Hard-on-Soft Prosthetic Hip Implant Bearings

Q. Allen, B. Raeymaekers, University of Utah, Salt Lake City, UT

Polyethylene wear debris causes osteolysis and premature failure of prosthetic hip implants. We design a pattern of texture features on the femoral head to increase the lubricant film pressure and thickness and reduce the polyethylene wear in hard-on-soft prosthetic hip implants. Specifically, we use a soft elastohydrodynamic lubrication model to study the effect of different axisymmetric texture floor profiles on the lubricant film thickness. We find the optimum texture parameters that maximize the lubricant film thickness for each texture floor profile as a function of bearing operating conditions. We find that flat texture floor profiles create thicker lubricant films than curved and sloped texture floor profiles. We compare the texture feature volumes of the optimum texture design parameters and find a linear relationship between the texture feature volume and the corresponding optimum lubricant film thickness that holds true independent of the axisymmetric texture floor profile.

The Interfacial Gradient and its Role in Ultralow Wear Sliding

I. Alam, D.L. Burris, University of Delaware, Newark, DE, J. Ye, J. Wei, J. Zeng, W. Sun, X. Liu, K. Liu, Hefei University of Technology, Anhui, China

In this paper, we elucidate the effects of interfacial gradients within the native ultralow wear PTFE composite-on-transfer film system using interrupted wear tests and intermittent surface analysis. As anticipated, the transition from high wear to ultralow wear was accompanied by small adherent debris, tribochemical formation of carboxylates, increased surface energy, and increased adhesion. Interestingly, we observed significant differences on either side of the interface during low wear sliding; compared to the running films on the composite surface, the transfer films on the counterface exhibited consistently greater tribochemical degradation, surface energy, and adhesion to a model alumina probe. This interfacial gradient, we propose, is a necessary feature of the ultralow wear system and functions by setting the direction and driving force for transfer wear. In this case, the interfacial gradient stabilizes the transfer film and minimizes the driving force for running film wear.

Molecular Dynamics Investigation of Core-Shell Nanostructures

S.E. Hughes, R. Fleming, Arkansas State University, Jonesboro, AK

Core-shell nanostructures (CSNs) are novel structures that have the potential to exhibit unique mechanical properties. Experimentally, surfaces patterned with Al/a-Si CSNs have been shown to have a low coefficient of friction and high durability. Molecular dynamics (MD) simulations can provide helpful insight into the material behavior of CSNs and help garner a better understanding of the physical mechanisms which enable these unique material properties. In this study, MD simulations are performed to investigate the role of core material and core-shell interface on the dynamics of dislocations nucleated within the core of CSNs during contact loading. Better understanding of the properties of CSNs will further enable their use in tribological applications, such as solid lubrication.

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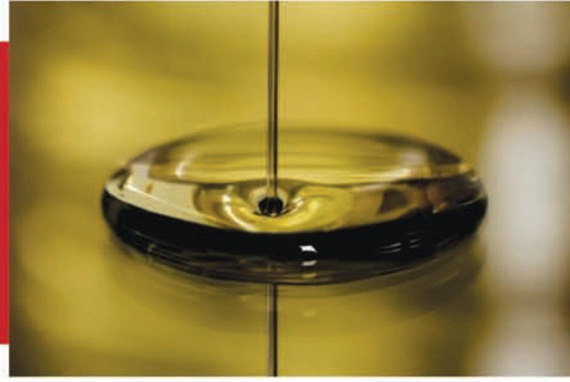

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