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AN stle PUBLICATION | MARCH 2025

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The Effect of Synovial Fluid Constituents on Boundary Lubrication of Superficial Area of Articular Cartilage
W. Li, T. Morita and Y. Sawae
Tribology Letters, Volume 73, 2025, Article 7.
Selected by Nicholas D. Spencer

Synovial joints are impressive lubricated bearings, capable of ultralow friction and remarkably resistant to wear. The joints owe their performance to the combination of articular cartilage and synovial fluid (SF). The underlying reasons for the excellent lubrication have been discussed for many decades, although a biphasic mechanism with a boundary molecular layer is now generally assumed. This paper endeavors to elucidate which components of SF and cartilage are responsible for the boundary lubrication. Friction measurements were carried out between cartilage and glass at ultralow loads, in order to minimize the cartilage tissue effects, and the cartilage surface was degenerated, either with solutions of detergent, to remove lipids and proteins, or salt, to remove lubricin. Various SF components (phospholipids, proteins and hyaluronic acid [HA]) were then used as lubricants and compared to SF itself. While SF showed very low friction even on the degenerated cartilage samples, HA and phospholipids had no apparent boundary lubrication effect. This was in contrast to the behavior of a mixture of albumin and γ-globulin, where the γ-globulin appeared to facilitate the adsorption of albumin, even on the degenerated samples, thereby leading to highly effective boundary lubrication. This synergistic behavior of the two proteins is an interesting new insight into this highly complex lubricating system.

Visualization of Structural Deformation of Polymer Additives in Oil Under High Shear Flow
T. Kusumoto, M. Kasai and M. Takenaka
Tribology Letters, Volume 72, 2024, Article 128.
Selected by Juliette Cayer-Barrioz

A newly designed cell has been used to perform small-angle X-ray scattering (SAXS) measurements at high shear rates, up to 10^5 s^{-1}, to quantify the deformation of polymer additives in oil. This technique was applied to low viscosity oil solutions containing 2% of poly(alkyl methacrylate) (PMA) with different molecular weights ranging from $4x10^4$ to $2.4x10^5$ g/mol. Analysis of the 2D SAXS patterns showed that the patterns became more anisotropic and elongated in the direction perpendicular to the shear flow direction with increasing PMA molecular weight. The radius of gyration of the polymer coils was then estimated in each direction, and the ratio between the radius of gyration in the parallel and perpendicular directions suggested that the relaxation time of the polymer increased with molecular weight. A correlation with the solution viscosity was then used to calculate the solution viscosity, allowing the authors to discuss the occurrence of shear thinning as a function of the molecular weight and shear rate. A significant effect of the polymer molecular weight was found: the deformation of the polymer coil and the occurrence of shear thinning were related to the increase in molecular weight. An additional comparison between these experimental results and simulations from the literature led the authors to suggest the role of long side chains in the chain stiffness and in the chain alignment along the flow direction.

Sliding on Slide-Ring Gels
A.R. Rhode, I. Montes de Oca, M.L. Chabinyc, C.M. Bates and A.A. Pitenis
Tribology Letters, Volume 72, 2024, Article 121.
Selected by David Burris

Recent investigations have pointed to physical entanglements that greatly outnumber chemical crosslinks as key sources of energy dissipation and low friction in hydrogel networks. In this paper, Rhode and colleagues investigate the tribological properties of slide-ring gels, an emerging class of hydrogels described by their mobile crosslinks. They synthesized a pseudo-rotaxane crosslinker from poly(ethylene glycol) diacrylate (PEG-diacrylate) and α-cyclodextrin-acrylate followed by hydrogel networks by connecting the sliding crosslinks with polyacrylamide chains. They measured the mechanical and tribological properties of slide-ring hydrogels using a custom-built microtribometer and observed unique behaviors compared to conventional covalently crosslinked polyacrylamide hydrogels. The results point to slide-ring gels as a class of hydrogels distinct from conventional hydrogels with fixed, covalent crosslinks. Slide-ring gels offer a vast design space for creating water-borne materials with unique mechanical and tribological behavior tailored for specific engineering applications, from biomedical devices to soft robotics.

Non-monotonic Evolution of Contact Area in Soft Contacts During Incipient Torsional Loading
B. Zhang, M. de Souza, D. M. Mulvihill, D. Dalmas, J. Scheibert and Y. Xu
Tribology Letters, Volume 72, 2024, Article 132.
Selected by Ken Nakano

Shear-induced contact area evolution is one of the hot topics in tribology. Although it happens in an anisotropic way, as the reduction mainly occurs along the shearing direction, whether such anisotropy is necessary has been an open question. The authors experimentally investigate the contact area evolution of elastomer-based sphere-plane contacts under an isotropic shear loading,

i.e., torsional loading. When macroscopic sliding is reached, the contact area has undergone a net area reduction. However, surprisingly, the area evolves non-monotonically as the twisting angle increases, with an initial rise to a maximum before dropping to the value during macroscopic sliding. The maximum to initial contact area ratio weakly depends on the normal load, angular velocity and dwell time within their investigated ranges. Besides, they also experimentally show similar non-monotonic area evolution occurs under unidirectional shear loading conditions under large normal force. These observations challenge the current descriptions of shear-induced contact area evolution and are expected to serve as a benchmark for future modeling attempts in the field.

Effect of Humidity on the Wear Behavior of Graphene Under Current Carrying Conditions
Q. Tang, Y. Huang, D. Sun and Q. Li
Tribology Letters, Volume 73, 2025, Article 8.
Selected by Ashlie Martini

Wear of sliding electrical contact components can be minimized by using conductive solid lubricants. However, understanding wear in such components requires understanding how the electrical conditions affect material removal mechanisms. This study focused on graphite-lubricated brass and the coupled effects of electric current and humidity. Results showed that increasing humidity can decrease the wear of graphite in sliding electrical contacts. Infrared temperature measurement and X-ray photoelectron spectroscopy component analysis indicated that multiple mechanisms contribute to this trend. First, at low humidities, the electric current increased the Joule heating which facilitated the evaporation of water and led to accelerated wear. However, the presence of water at higher humidities decreased the Joule temperature rise and, therefore, decreased wear. Finally, the XPS analysis showed that humidity was beneficial for the passivation of carbon dangling bonds on the graphite, even in the presence of electric current. These findings show there is interplay between the well-known effect of humidity on graphite wear and electrical conditions that may be present in some emerging applications for which graphite may be useful as a solid lubricant.