Editorial for Special Issue on Biotribology and Biointerfaces

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Biotribology and biointerfaces stand at the forefront of interdisciplinary tribological research, bridging tribology, materials science, biology, and medicine to address critical challenges in healthcare, implant technology, and bioengineering. Over the past decade, the *Friction* Journal has published two special issues related to biotribology and biomedical tribology. Building on these studies, recent advances in biotribological mechanisms, biointerface engineering, and materials innovation—driven by cross-disciplinary collaborations—have led to the need for a third special issue.

This special issue, Biotribology and Biointerfaces, features 13 high-quality papers, covering topics in biotribology and biointerfaces as well as their related phenomena—from biomimetic materials design fundamental tribological mechanism analysis to interface engineering and clinical translation. This collection aims to identify and propose potential applications of biotribology and biointerfaces in bioengineering, biomedical engineering, and clinical medicine.

Chen et al. review the latest advances in overcoming the key limitations of biomedical hydrogels, focusing on two interconnected pillars: mechanical enhancement and biomimetic lubrication. By integrating structural and functional biomimicry of natural articular cartilage, the review not only concludes innovative design strategies but also clarifies their mechanisms—providing a roadmap for developing hydrogel substitutes that match the performance of natural cartilage. (https://doi.org/10.26599/FRICT.2025.9440984)

Feodor M. Borodich's group elaborates the recent advances in contact mechanics modeling for biomimetic artificial adhesives, inspired by the hair-like hierarchical adhesive systems of geckos, insects, and other organisms with exceptional climbing abilities. They note the evolution of the modeling from simple to complex multilevel hierarchical structures, focusing on adhesion/friction models that account for such hierarchies—especially those based on Cantor–Borodich profiles—and summarize recent progress on artificial setae with spatula-like ends. (https://doi.org/10.26599/FRICT.2025.9441016)

Inspired by the adhesive properties of mussels, the superlubricity of articular cartilage, and the antimicrobial effects of coumarin derivatives, the paper entitled “Bioinspired self-adhesive coating for surface functionalization of medical devices with lubrication and antibacterial properties” introduces a self-adhesive copolymer that combines lubricating and antimicrobial functionalities. This copolymer, when applied to titanium substrates, has demonstrated lubrication, antimicrobial effects, and durability, showing great potential for the functionalization of medical device surfaces. (https://doi.org/10.26599/FRICT.2025.9440926)

The paper entitled “MAP-inspired dual crosslinked PVP-phenol sprayable hydrogel coating for stable marine antifouling applications” addresses the shortcomings of traditional marine antifouling paints, which fail to meet green antifouling requirements, and the poor constructability and wet mechanical stability of existing hydrogel coatings. Through prepolymer-reactor rapid contact molding, the paper presents a method for developing sprayable hydrogel coatings: polyethyleneimine (PEI) facilitates chemical crosslinking into MAP-mimetic reticular scaffolds, while vanadium pentoxide (V_2O_5) converts PG to PG-quinone, which offers new insights into enhancing the wet adhesion properties of hydrophilic marine antifouling coatings. (https://doi.org/10.26599/FRICT.2025.9440946)

The paper entitled “A novel hydroxyapatite-modified MXene-based hydrogel coating on Ti6Al4V alloy with improved biotribological properties and corrosion resistance” presents a novel hydroxyapatite (HA)-modified MXene (polyvinyl alcohol (PVA)/polyacrylic acid (PAA)/polydopamine (PDA)/hydroxyapatite (HA)-MXene) hydrogel coating on Ti6Al4V alloy. This coating is developed using sol-gel, cyclic freezing-thawing, and chemical self-assembly techniques. The enhanced biotribological properties and corrosion resistance are confirmed through tests conducted in simulated body fluid. The mechanisms involved include the formation of lubrication films, sliding/rolling friction (HA-MXene), and the blocking effect of MXene. This study proposes an innovative idea of surface modification design for the application of titanium alloy implants in the field of orthopedics. (https://doi.org/10.26599/FRICT.2025.9440956)

Tribocorrosion at the taper–trunnion interface of artificial hip prostheses can compromise their performance and service life. The paper entitled “Tribocorrosion behavior at the taper–trunnion interface of artificial hip prostheses with different femoral head materials” addresses this by using a hip joint simulator—overcoming the limitations of prior simplified ball-on-disk models—to compare the tribocorrosion of Ti6Al4V femoral stems paired with three different femoral head materials (CoCrMo alloy, zirconia-toughened alumina (ZTA) ceramics, and zirconium–niobium (ZrNb) cermet) under physiological conditions. The results show that material loss in all pairs is primarily wear-driven, with CoCrMo–Ti6Al4V suffering the greatest loss. This study thus

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provides valuable guidance for selecting optimal materials for hip replacements. (https://doi.org/10.26599/FRICT.2025.9440985)

The paper entitled "Finite element analysis of biomechanical alterations in the temporomandibular joint following mandibular reconstruction" focuses on the biomechanics of the temporomandibular joint (TMJ) subsequent to mandibular resection and reconstruction. It investigates the effects of masticatory muscle loss on TMJ stress, identifies the optimal loading conditions to minimize stress on the contralateral side, and explores the impact of friction. This study helps clarify the post-surgical changes in asymmetric anatomy and frictional conditions, which lead to higher stress on the contralateral TMJ. Importantly, the findings have great clinical value for choosing the right, personalized occlusal loading to mitigate excessive contact pressure and potential damage to the articular joint. (https://doi.org/10.26599/FRICT.2025.9441013)

The paper entitled "Interaction of Pluronic F-127 with serum proteins and its feasibility as a lubricant additive for CoCrMo/UHMWPE interface" investigates the potential of F-127 as a lubricant for the CoCrMo/ultrahigh molecular weight polyethylene (UHMWPE) in a serum. The addition of 0.1%–20% F-127 to serum results in an immediate reduction of the friction coefficient by approximately 20%, as F-127 adsorbs more rapidly than serum proteins. Spectroscopic analyses indicate that F-127 monomers do not interact with serum proteins. However, once the concentration exceeds the critical micelle concentration (CMC), micelles bind to γ-globulin and albumin. The present study conducts a feasibility test of Pluronic as a lubricant for UHMWPE surfaces in biological fluids and examines the interaction between Pluronic and biomacromolecules. (https://doi.org/10.26599/FRICT.2025.9441036)

The paper entitled "Film formation and lubrication mechanisms of whey proteins and mucin" examines how whey protein isolate (WPI) and salivary mucin create films on surfaces and affect oral lubrication. With its superior adsorption capacity, mucin can displace WPI, yet it also promotes the formation of a mucin-WPI hybrid film. This adsorption adheres to the pseudo-second-order model. Depending on the nature of the contact, these films exhibit different lubricating properties. Mucin decreases friction, enhances the uniformity of WPI films, improves their smoothness, and reduces mouth-drying, thereby influencing the perception of more flavorful foods. This paper could contribute to the development of novel, protein-based, healthy, tasty, and sustainable diets. (https://doi.org/10.26599/FRICT.2025.9441038)

The paper entitled "Employing knowledge transfer in machine learning for wear assessment on synthetic and biological materials" presents a method that utilizes knowledge transfer to classify three types of mechanically induced wear. This is accomplished by integrating two random forest models: a base model trained on extensive synthetic datasets and a complementary model on sparse cartilage data. The method achieves an accuracy of up to 95%, surpassing state-of-the-art two-class methods, and requires only approximately 12 training samples. This study provides a highly adaptable framework for assessing wear on biological samples, requiring only a small amount of training data. It also proposes a useful approach for many other areas of materials science where obtaining training data is challenging. (https://doi.org/10.26599/FRICT.2025.9441039)

The paper entitled "Robust hydrogels with orderly assembly of hydroxyapatite induced by temperature gradient" presents a novel hydroxyapatite (HA) composite hydrogel that was developed through molecular network design, temperature-induced orientation, and nanoreinforcement. It features a vertically ordered honeycomb-like network, exhibiting high water content, superior strength, low friction, and fatigue resistance. This study enhances cartilage replacement materials and broadens applications in load-bearing artificial tissues, medical coatings, and soft robot joints. (https://doi.org/10.26599/FRICT.2025.9441046)

The paper entitled "Study on the protein adsorption and properties of self-assembled chitosan coating" details the development of a self-assembled chitosan coating. This is accomplished by polymerization co-deposition of a polydopamine/polyacrylic acid (PDA/PAA) interlayer under acidic conditions, followed by the immobilization of chitosan activated with 1-ethyl-(3-dimethylaminopropyl) carbodiimide hydrochloride (EDC)/N-hydroxysuccinimide (NHS). The coating enhances wettability and results in a 4.43-fold increase in protein adsorption compared to uncoated surfaces. This is attributed to electrostatic interactions and increased roughness. The coating exhibits good biocompatibility, improving mouse osteoblast viability and promoting proliferation, while also demonstrating stable water resistance. It is effective on polydimethylsiloxane (PDMS), polymethylmethacrylate (PMMA), aluminum, and glass, providing a promising strategy for biomedical coatings in applications that involve protein adsorption and detection. (https://doi.org/10.26599/FRICT.2025.9441074)

The last paper entitled "Robust low friction mechanism of HNT-PVPA composite coating based on microviscosity regulation" reports developing a halloysite nanotube (HNT)-polyvinylphosphonic acid (PVPA) composite coating on Ti6Al4V for artificial implants. It is designed to reduce friction, improve durability, and perform well over wide speeds and in body fluids. Its low-friction mechanism: HNTs' inner/outer wall charge differences attract ion aggregation; these ions form hydrogen bonds with water, increasing interface microviscosity and retarding water diffusion. Additionally, HNTs enhance the coating's toughness, thereby improving its resistance to multivalent cations. This study presents a novel method for creating stable, low-friction biotribological coatings. (https://doi.org/10.26599/FRICT.2025.9441084)

We hope this special issue can serve as a vital platform for knowledge exchange in biotribology and biointerfaces, and pave the way for innovative solutions that bridge the gap between basic research and translational application.