Surface Insights: Exploring Glass and Carbon Tribology

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Due to its mechanical and chemical stability as well as its optical transparency, silicate glass is instrumental in the modern world. These key attributes are highly dependent on both the condition and properties of the glass surface, where even slight imperfections can decrease the strength of glass by several orders of magnitude. Therefore, developing an understanding of the glass surface is equivalent to developing an understanding of the glass itself.

We investigated the tribological behavior of carbon materials, focusing on the hydrogenated diamond-like carbon (HDLC) coating. It exhibited significant friction reduction during macro- and micro-sliding but higher friction during nanoscale sliding, even after the running-in period with graphitic carbon transfer films. Raman analysis revealed reduced graphitization with decreasing contact scale, attributed to vastly different contact areas. In nano-sliding and fretting, limited transfer film retention due to the tiny contact area constrained shear-induced graphitization, elevating friction compared to macro- and micro-sliding.

The tribochemical yield is highest in O_2, followed by N_2 and H_2O. However, wear of surfaces after sliding in these three different environments is approximately the same. This similarity can be attributed to the initial removal of oxygen from the surface, followed by surface oxidation due to the presence of oxygen in the environment. Consequently, the wear of the surface does not increase significantly with the tribopolymerization yield.

To this end, our group uses a combination of spectroscopy, mechanical testing, frictional and chemical testing to build a more complete understanding of the interactions between the surface of glass, HDLC, metal and its environment. Some results from this work have included a new IR peak assignment which challenges a decades old correlation, understanding the unique high humidity wear resistance of soda lime silica glass, and revealing how invisible damage after a nearly elastic contact significantly increases the cracking probability.