

SUPERLUBRICITY AND SUPER WEAR: TRIBOCHEMICAL INTERACTION OF HYDROGEN-FREE TETRAHEDRAL CARBON COATINGS (TA-C) WITH OLEIC ACID

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ABSTRACT

Since the first report of liquid superlubricity with ta-C coatings in the pioneer work of Kano et al. in 2005, the special interaction of lubricants with such coatings has sparked great interest. Despite several experimental and analytical findings adding puzzle pieces to the superlubricity phenomenon, a full understanding has not been obtained. Besides the superlow friction effect there is some scattering in reports on wear of ta-C coatings. Depending on the tribological conditions, wear of the coating is sometimes high, though the coating has much higher hardness compared to the uncoated counter body.

In this study we focus on the tribochemical interaction of oleic acid with ta-C coatings and show how tribological conditions can both cause high wear or superlow friction. Using a large parameter study we first investigated a tribochemical wear phenomenon and identified the role of sp³-fraction, amorphicity, temperature, counterbody material, lubricant chemistry and contact pressure. In the second part of the study, we achieved superlubricity with no measurable wear by adjusting the tribological conditions. We studied the effect of lubricant chemistry and contact pressure, considering lubricant film thickness and tribo-induced rehybridization effects.

We found that a tribochemical wear process occurs for fatty-acid based lubricants, which is unique to ta-C coatings, temperature activated and most likely catalyzed by the counter body [1]. Under such conditions that occur under very high contact pressures, wear can increase by several orders of magnitude.

When we studied effects outside high wear conditions, we could obtain superlubricity with both self-mated and single-side coated ta-C coatings. An accompanying study[2] revealed that the investigated system, opposed to other studies, was running in boundary lubrication conditions. Raman spectroscopy

showed that a tribo-induced rehybridization of sp³ carbon in the subsurface volume was not associated with superlubricity. However, DFT simulations found evidence of graphenization of the top surface atom layer, supporting recent analytical finding by De Barros Bouchet et al.[3]

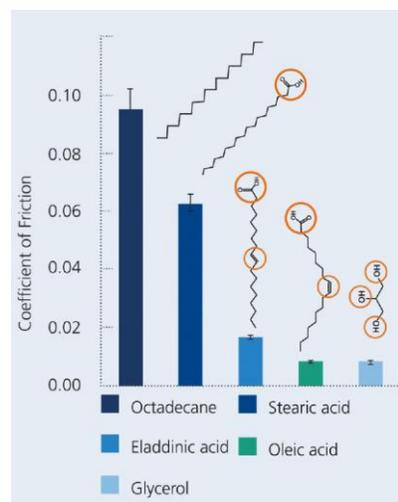


Fig.1 Superlubricity of self-mated ta-C coatings could be achieved with unsaturated oleic acid and glycerol. Saturated stearic acid has much lower reactivity and results in much higher friction common to boundary lubrication.

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REFERENCES

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