Insights on the humidity influence on graphite-phenolic resin solid lubricants in highly loaded contacts

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Abstract

Friction and wear in the moving components which constitute a significant share of the mechanical systems we use can lead to important energy and materials losses. That is why it is of paramount importance to develop lubricants that withstand harsh conditions for extended periods of time. In fact, solid lubricants have proven to exhibit favourable tribological properties where liquid lubricants tend to be of restricted use. Graphite, notably as a solid lubricant coating, has shown fabulous lubricating properties under high mechanical loads and in the presence of relatively high humidities (1). However the lifetime remained quite limited. On the other hand, our previous work has shown that when graphite is mixed with phenolic resin as a binder it has exhibited a remarkable tribological behaviour. Indeed, the addition of phenolic resin to graphite improved the lifetime 50-fold meanwhile keeping a comparable lubricity to the one reported with pure graphite. Though, it is well established that the lubricity of graphite is humidity-dependent (2), this leaves us with an open question: is there a humidity influence of the tribological properties of graphite-phenolic resin blend? If yes, how? In this work we attempt to bring in further insights and understanding of the influence of humidity of the aforementioned solid lubricant by conducting highly loaded tribological tests when tested on a ball-on-flat reciprocating motion in controlled environments. We employ surface-analytical tools as well to further characterise the obtained tribofilm, hence, unveiling the underlying lubricating mechanisms of these solid lubricants.

(1) C.E. Morstein et al. Wear, V-477,2021.
(2) C.E. Morstein et al. Nature Communications, 2022, 13, 5958.

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