Bifunctional tribofilms derived from inorganic borate on heated rubbing interface

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ABSTRACT

The extreme state of friction, wear and oxidation invariably occurs in the rolling process of steel components, especially at elevated temperatures (800^{o}C). The use of high temperature lubricants to mitigate the aforementioned difficulties will boost process productivity. Most conventional lubricants have failed to perform due to their poor thermal stability. On the other hand, glass lubricants are reportedly quite effective for anti-friction, anti-wear and anti-oxidation behaviors [1, 2].

In this study, tribological responses of alkaline metal borate are evaluated in hot friction testing of steel contact. The generated tribofilm induces a significant reduction in friction coefficient, material loss as well as oxidation. Under tribological exposure, the interaction between lubrication molecules and oxide scale results in the formation of *in-situ* tribo film which accounts for wear and oxidation inhibition. The tribofilm consists of two layers : (i) an upper viscous layer of borate which contributes predominantly to anti-friction function (ii) a lower layer which consists of iron, boron, alkaline and oxygen elements. The two tribochemically-yielded tribo-layers perform complementary functions that enhance the lubrication synergistically. The study indicates boundary/mixed-film regime for glass lubrication where an evolution mechanism of the layered films is also proposed. Multiple surface characterization techniques including AFM, XPS, SIMS and FIB/TEM were employed to provide insights into the structural nature of borate tribofilm.

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