Tribotronic Control of Ionic Boundary Films

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With modern machines becoming more compact and electrified (for increased power density), the demands on lubrication systems are increasing. As a result, alternate lubrication concepts, like tribotronics, are emerging. Because of their ionic nature and controllability of interfacial structure with electric potential, ionic liquids have emerged as viable candidates for tribotronic systems. In this study, a non-halogenated phosphonium orthoborate ionic liquid used as an additive in a biodegradable oil was studied for the effect of electric potential on lubricating adsorbed ionic films. Designed around a ball-on-disc film thickness measurement system, a tribotronic system was developed and manufactured in-house. In this setup the tribo-track could be subjected to an electric potential between a set of counter electrodes and a test ball. At negative potentials, the lubricating film thickness decreased, while at positive potentials, it increased. These trends revealed that the anions, performing a function of anchoring on the surface, contributed significantly to the formation of thick and robust lubricating ionic boundary films. A high potential outside the electrochemical window resulted in a substantial increase in film thickness, suggesting the formation of multilayer ionic films, thus revealing a potential avenue for lubrication restoration using tribotronics. Electroresponse was also observed in the complementary neutron reflectance experiment in the form of changes in the thickness and ionic composition of the boundary films.

Keywords: Tribotronics, Lubrication, Ionic liquid, boundary film

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