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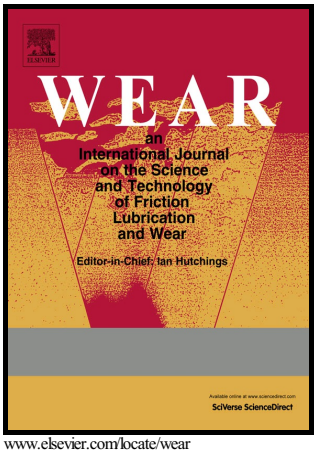

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Effects of protic ionic liquid crystal additives on the water-lubricated sliding wear and friction of sapphire against stainless steel

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Abstract

Additives for water lubrication of a sapphire-stainless steel contact have been developed by adding 1 wt.% protic ammonium carboxylate ionic liquid crystals (ILCs) derived from stearic and palmitic fatty acids. Triprotic (2-hydroxyethyl)ammonium stearate ~~$[HOCH_2CH_2NH_3]^+$ $[CH_3(CH_2)_{16}COO]^-$ (MES)~~, diprotic bis(2-hydroxyethyl)ammonium stearate ~~$[(HOCH_2CH_2)_2NH_2]^+$ $[CH_3(CH_2)_{16}COO]^-$ (DES)~~ and bis(2-hydroxyethyl)ammonium palmitate ~~$[(HOCH_2CH_2)_2NH_2]^+$ $[CH_3(CH_2)_{14}COO]^-$ (DPA)~~ have been studied. In unidirectional, pin-on-disk tests of sapphire against type 316L stainless steel, the additives reduce the coefficient of friction up to 80%, from the start of the sliding, and reduce or prevent ~~the~~ increase of the friction at the lubricated-dry contact transition after water evaporation. The wear rate of the stainless steel is reduced by one order of magnitude. The main mechanism for prevention of surface damage is the reduction of iron oxidation inside the wear track due to adsorption of the ILCs additives. SEM/EDX, TEM, XPS surface analysis, Raman spectroscopy and profilometry results are discussed.

Keywords: Ionic liquid crystals; fatty acids; water; bio-based lubricants.

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