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Protic Ionic Liquids as Additives to Lubricate Silicon Surfaces

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PURPOSE OF THE ABSTRACT

Ionic Liquids (ILs) as low-melting organic salts exhibit interesting physico-chemical properties such as high chemical and thermal stability, almost negligible vapor pressure, high ionic conductivity, non-flammability and ease in dissolving organic, inorganic and polymeric materials. One of the most attractive characteristics of ILs is related with the possibility to design the cation-anion combinations according to the desired properties as well as the final application in several research fields. [1]

One of the potential applications of ILs is focused in the discovery of efficient lubricants for NEMs/MEMs (nano/microelectromechanical) devices, which are a set of new devices that will significantly change our day-to-day lives in the next few decades. In 2018, the global total value in the market for these devices was 10 billion euros and that value is expected to reach 50 billion until 2024. ILs as promising lubricants for this type of systems have been recently reported.[2] As they are conductive fluids, ILs lead to the minimization of the contact resistance between sliding surfaces, which it is an important parameter for various electrical applications.[2,3] However, since the manufacturing costs of ILs are usually high, their application as neat lubricants is impracticable. A viable solution to overcome this drawback is the use of ILs as additives to commonly used base oils.[2-4]

Protic Ionic liquids (PILs) are a subclass of ILs that have recently been considered as potentially good lubricants. The PILs composed by protonated ammonium cations possess the advantage of being easily prepared with low cost and toxicity. Besides that, they exhibit low viscosity when compared to the conventional aprotic ionic liquids, making them good candidates as lubricants.

Herein, we report the use of protic ILs based on different organic cations combined with two anions (hydrogen sulfate and methyl sulfate) as additives to the commonly used base oil PEG 200 and assess the tribological performance, namely friction and wear. All the prepared lubricants were characterized in terms of their water content, viscosity, wettability and tribological properties. The friction coefficients were measured using steel and silicon spheres against Si surfaces. The most promissory PILs containing the protonated cation 4-picolinium showed a good tribological performance, both in terms of friction and wear reduction comparing to commercial lubricant PEG 200 making them very good candidates for future applications in electronic devices.

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FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

Protic Ionic Liquids | Libricants | NEMs/MEMs | Tribology

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