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Effect of Relative Humidity on Lubricating Performances of Halogen-Free Ionic Liquids

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Ionic liquids are expected to be used as novel lubricants. However, halogen-contain ionic liquids often generate HF gas and cause the corrosion wear by the moisture. On the other hand, the friction coefficient of halogen-free ionic liquids is increased because they show hydrophilic property and moisture inhibits the reaction with the friction surface. Since cations mainly control the physical properties of the ionic liquids, phosphonium cations can be used to improve hydrophobicity. This investigation conducted the friction tests of halogen-free ionic liquids consisted of phosphonium cation and halogen-free anion under different relative humidity.

Keywords: Friction, Ionic liquids, Lubricating performance, Moisture.

1. Introduction

Lubricant are often used in many mechanical parts to reduce the friction loss. Ionic liquids are expected to be used as novel lubricants. However, the moisture affects lubricating performances of halogen-free ionic liquids because that ionic liquids show hydrophilic property. Since cations mainly control the physical properties of the ionic liquids, phosphonium cations can be used to improve hydrophobicity. This investigation conducted the friction tests of halogen-free ionic liquids consisted of phosphonium cation and halogen-free anion under different relative humidity.

2. Methods

Two types of ionic liquids were used as lubricant: Trihexyltetradecylphosphonium dicyanamide ([P66614][DCN]), Trihexyltetradecylphosphonium tricyanomethanide ([P66614][TCC]). Both liquids exhibit hydrophobicity. The lubricating performances of halogen-free ionic liquids were evaluated using house-made ball-on-disk friction tester. Both sliding materials were made of bearing steel. The relative humidity was maintained at 15, 50, and 80 %, respectively. The operating parameters for the sliding tests were: temperature = room temperature, load = 3.5N (contact pressure =1299MPa), sliding velocity =52mm/s, and test duration = 60 min. The wear scar diameter of ball specimens were obtained by laser microscopy.

3. Discussion

Figure 1 shows the result of friction coefficients lubricated with each ionic liquid under the different relative humidity. [P66614][DCN] shows lower friction coefficient than [P66614][TCC]. There was little difference in the friction coefficient at each relative humidity. From this result, it is considered that the hydrophobic ionic liquid is not easily affected by moisture. Figure 2 shows the wear scar diameter of ball specimens. Both ionic liquids exhibited almost the same values. As the relative humidity rises, wear scar diameters of both ionic liquids were increased. And wear scar diameter at 80% shows the highest value. From the observation with a laser microscope, in the experiment at a humidity of 80%, deterioration of the test piece was confirmed. It is considered that the test piece was corroded, which led to an increase in the wear scar diameter. From these result, affinity of the ionic liquids with moisture may have a significant effect on lubricating phenomena.

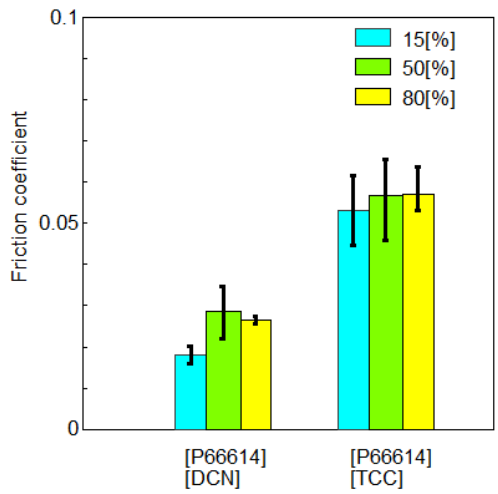

Figure 1: Friction coefficients.

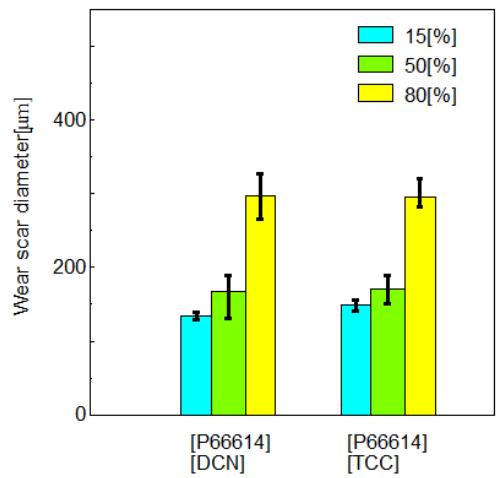

Figure 2: Wear Scar diameter.