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Friction Control by Applied Potential on Friction Surface under Lubrication with Ionic Liquids

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It is well known that friction coefficient under lubrication is greatly affected by adsorption molecular on the friction surface. This investigation focused on the ionic liquids and conducted that the adsorption structures of the ionic liquids on the friction surface was switched by the applied potential. When the negative voltage was applied on the worn surface, the value of friction coefficient was lower than the case of 0V. This result indicate that the friction coefficient is reduced by cation-rich layer on the friction surface.

Keywords : friction control, ionic liquids, surface potential

1. Introduction

As represented by Hardy's surface adsorption model, it is well known that friction coefficient under lubrication is greatly affected by adsorption molecular on the worn surface [1]. Therefore, it is considered that friction reduction can be achieved by understanding the adsorption structures at the solid-liquid interface and controlling this layer. This investigation focused on the electric characteristic of ionic liquids. These liquids are expected to be used as novel lubricants [2]. In addition, their interface structures depend on the electric potential of a solid surface [3]. This investigation conducted the adsorption structures of the ionic liquids on the friction surface was switched by applied potential to control the friction coefficient.

2. Methods

2.1. Materials

Butyl-1-Methyl-Pyrrolidinium Dicyanamide [BMPL] [DCN] was used as lubricant. This liquid was purchased from Merck Chemicals (Germany) at > 98 % purity, with a water content of <1000ppm.

For the sliding test specimens, a ϕ24 mm × t 7.9 mm disk and ϕ 10 mm ball made of bearing steel (AISI 521000) were applied. To prevent electric corrosion and energization between both specimens, disk specimen was coated with the diamond-like carbon (a-C: H film).

2.2. Sliding conditions

The friction behavior by applied potential under lubrication with ionic liquid was evaluated using an in-house instrument ball-on-disk friction tester. The disk specimen was connected to an electrode. Platinum was used as a counter electrode, and inserted into the ionic liquids. The operating parameters were a load of 1.2 N (Hertz contact pressure 492 MPa), rotation speed of 80 rpm (50 mm/s), applied potentials 4.0 or -4.0 V.

3. Discussion

Figure 1 shows the friction behavior of [BMPL] [DCN] depend on applied potential. When the positive voltage was applied, the friction coefficient did not change. On the other hand, the case of negative voltage, the friction reduction was confirmed. When the friction reduction was confirmed, it is considered that [BMPL] cation was adsorbed on the friction surface by the electrical interaction.

4. References

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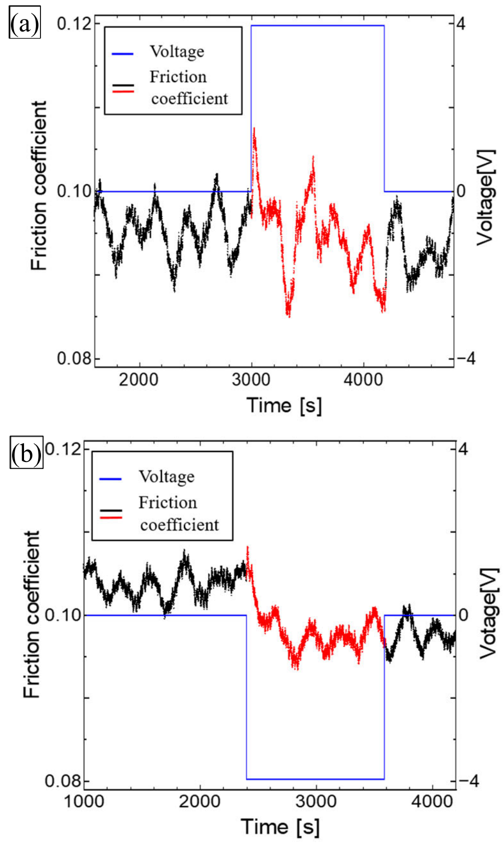

Fig. 1 friction behavior depend on applied potential (a) +4.0 V, (b) -4.0V