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Lubrication Properties of Ionic Liquid with Polymer Particles Dispersing

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In this investigation, we proposed a novel method for nano-micro particle dispersion in ionic liquids, and manufactured *N*,*N*-Diethyl-*N*-methyl-*N*-(2-methoxyethyl)ammonium bis(trifluoromethane-sulfonyl) imide ([DEME][TFSI]) which fluorinated polymer particles are dispersed in. The frictional properties of [DEME][TFSI] only and [DEME][TFSI] + fluorinated polymer particle were evaluated. As a result, this investigation found that the dispersion of fluorinated polymer particle in ionic liquids by the proposed method can improve the frictional properties.

Keywords: ionic liquid, nano particle, frictional property, radical polymerization

1. Introduction

In recent years, ionic liquids have attracted attention as lubricants in extreme environments such as high vacuum. Ionic liquids are salts composed of cations and anions of organic materials and have excellent characteristics in non-volatility, thermal stability, ionic conductivity and tribology properties in comparison with conventional oils. In addition, the dispersion of nano-micro particles such as carbon nanotube and various metals in ionic liquids can improve physical properties[1] or add properties such as magnetism. However, it is difficult to disperse particles in ionic liquids because of slow development of suitable surfactants for ionic liquids. Direct particle production by sputtering could cause damage to ionic liquids. In this study, we proposed the novel method for direct particle production in ionic liquids by radical polymerization. The proposed methods can simply produce organic particles in ionic liquid without damage to ionic liquid by radical polymerization using blue light, which is non-absorption wavelength. [DEME][TFSI] which fluorinated polymer particles are dispersed in was manufactured by the proposed method, and the tribology properties were assessed experimentally.

2. Polymerization methods

In this study, [DEME][TFSI] was used as dispersion medium, and two monomers (1,6-Bis(acryloyloxy)-2,2,3,3,4,4,5,5-octafluorohexane and 1H,1H,2H-Hepta-decafluoro-1-decene) were prepared for radical polymerizetion. [DEME][TFSI] which fluorinated polymer particles are dispersed in was obtained in following steps.

(1) The liquid mixture obtained by mixing two monomers and a photoinitiator (Omnirad 819, IGM Resins B.V.) is dropped in ionic liquid.
(2) The ionic liquid is agitated physically and ultra-sonically.
(3) Two monomers are co-polymerized by blue light irradiation and fluorinated polymer particle are generated.

Figure 1 shows the photograph of the fluorinated polymer particle generated by the proposed method.

3. Experimental results

Figure 2 shows the variations of the frictional coefficient of [DEME][TFSI] only and [DEME][TFSI] + polymer particle as function of time during reciprocating-sliding motion. When [DEME][TFSI] only was used, the frictional coefficient under test loads showed stable behavior and attained a value of 0.06~0.07 a few minutes after the commencement of the test. On the other hand, when [DEME][TFSI] + polymer particle was used, the frictional coefficient decreased with test time, and the value at the end of test was less than 0.06. This result indicates that the dispersion of fluorinated polymer particle in ionic liquids by the proposed method can improve the frictional properties.

4. References

[1] Wang, B. et al., “Rheological and Tribological Properties of Ionic Liquid-Based Nanofluids Containing Functionalized Multi-Walled Carbon Nanotubes”, J. Phys. Chem. C, 114, 2010, 8749.

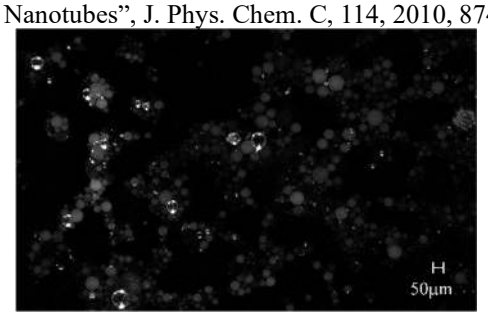

Figure 1: Photograph of fluorinated particles polymerized by proposed method

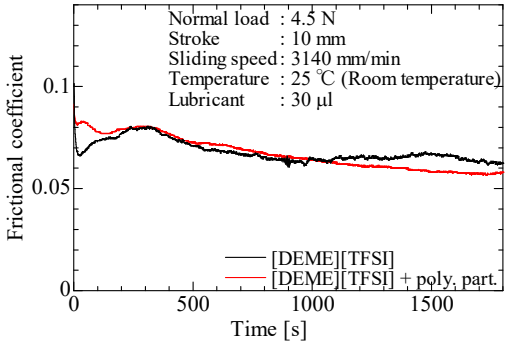

Figure 2: Friction behavior of [DEME][TFSI] and [DEME][TFSI] + fluorinated polymer particles.