

How does the water mixed with Ionic Liquids behave under lubricating condition?

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1. Introduction

Room-temperature ionic liquids (RTILs) have properties such as high thermal stability, low volatility, non-flammability, low melting point, and broad liquid range, which are applicable to superior lubricants and additives [1,2]. Previous researches on RTILs as a lubricant have mainly focused on the characterization of various types of RTILs and synthesizing novel functionalized RTILs. Tetrafluoro-borate (BF_4) and hexafluoro-phosphate (PF_6) are the two of the most commonly used anions and RTILs based on the 1-n-alkyl-3-methylimidazolium cation with either the BF_4 or PF_6 anion are known to be effective lubricants. However, both BF_4 and PF_6 have been found to undergo complex tribo-chemical reactions [2] and to produce corrosive hydrofluoric acid (HF) in the presence of water, which is inevitably present in practical use [3]. To understand the lubrication mechanism and design RTILs suited for lubricants, it is important to clarify the molecular behavior of water which mixed into RTILs under lubricating condition.

2. Experiment

In this study, the molecular behavior of RTILs and water under lubricating condition was investigated by use of Fourier transform infrared (FT-IR) spectroscopy equipped with a pin-on-disk tribometer that enables simultaneous measurement of the friction force, normal load, and IR spectrum. Calcium fluoride (CaF_2) window material was used as the disk for the tribometer. SUJ2 with a diameter of 8 mm was used for the pin specimen. Imidazolium-based RTILs were used as the lubricants.

3. Result and Discussion

At first, the RTIL was sandwiched between the pin and the disk with 36mN, which corresponds to the weight of the pin. This condition was maintained for 72 hours. IR spectrum was obtained every 5 minutes. Figure 1 shows the time dependent change of the IR spectrum in the range between 2800 and 3800 cm^{-1} . This region includes the peaks of C-H stretch mode and O-H stretch mode. From beginning of the test, the peak of O-H stretch mode located at 3550 cm^{-1} , which corresponds to water, was observed and the intensity increased with time. However it exceeds 5 hour, another O-H peak was appeared at 3400 cm^{-1} . This result indicated that there is some difference in the state of water absorbed in [BMIM]OTf [4]. The difference in the state of absorbed

water also would affect the tribo-corrosion or frictional properties of [BMIM]OTf. We are going to perform further experiment such as an observation under lubricating condition, and will discuss the effect of water mixture on the tribological properties of RTILs.

4. References

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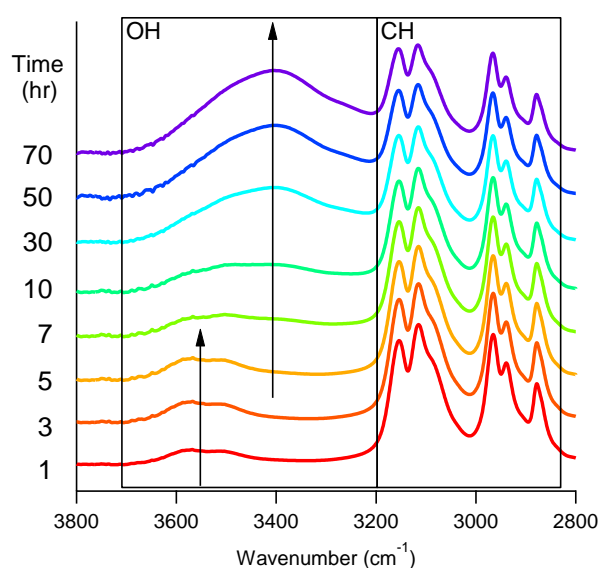


Fig.1 Time variation of IR spectrum of CH and OH stretching mode