FM-AFM OBSERVATION ON EFFECT OF WATER ON ADSORPTION LAYER OF HYDROPHOBIC AND HYDROPHILIC IONIC LIQUIDS

S. Kawada [a*], Y. Sato [b], S. Sasaki [a], M. Miyatake [a]
*s-kawada@rs.tus.ac.jp
[a] Tokyo University of Science,
6-3-1 Niijyuku, Katsushika-ku, Tokyo, Japan
[b] Graduate School of Tokyo University of Science,
6-3-1 Niijyuku, Katsushika-ku, Tokyo, Japan

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ABSTRACT
Ionic liquids are salts that exist as liquid at room temperature. They have been used as new lubricants because of their attractive properties, such as low vapor pressure, high thermal stability, and flame resistance [1]. Moreover, these physical properties can be controlled by changing ion pairs. To know lubricating mechanism, it is important to clarify adsorption structures of lubricants. Especially, ionic liquids form specific adsorption layer derived from surface smoothness and ion interaction [2, 3]. However, there is possibility that the adsorption structure of the ionic liquids are disturbed by the presence of water because ionic liquids, and this phenomenon cause degradation of tribological performances of ionic liquids [4, 5]. This investigation evaluated that the adsorption structures of ionic liquids using Frequency modulation atomic force microscopy (FM-AFM, SPM-8000, Shimadzu, JP), which have higher force resolution than conventional AFM. In addition, the effect of water as impurity on adsorption structures of ionic liquids.

This investigation used 1 - Butyl - 3 - methylimidazolium dicyanamide ([EMIM][DCN]) with a purity of > 98% and water content of <10000 ppm (Merck). This ionic liquids show hydrophilic. Before use, [BMIM][DCN] was evacuated at a pressure of 1.0×10^{-4} Pa for 48 hours. Mica was used as the solid substrate and was washed with ethanol before analysis. A cantilever was made of silicon (NCHR, NANOSENSORS, Germany). The spring constant is 42 N/m. Before the measurements, the cantilever was washed with ethanol. Force curve measurements were performed at an amplitude of 40 mV (approximately 4 Å), measurement speed of 5 Hz, temperature of 25°C, and relative humidity of 50%.

Figure 1 shows the Z - X mapping image of the force curve of the [BMIM][DCN]. The high-brightness region indicates high repulsive force. This results indicated the ionic liquids form mult-adsorption layer. This layer will work as protection film against normal load. In the presentation, the adsorption layer of hydrophobic ionic liquids and effect of water on adsorption layer will be shown.

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REFERENCES
[1] Kondo, Y., Yagi, S., Koyama, T., Tsuboi, R. and Sasaki, S., Proc. Inst. Mech, Eng. J: J Eng. Tribol. 226, 2012, 991-1006.
[2] Sakai, K., Okada, K., Uka, A., Misono, T., Endo, T., Sasaki, S., Abe, M. and Sakai, H., Langmuir. 31, 2015, 6085-6091.
[3] Li, H., Endres, F. and Atkin, R., Phys. Chem. Chem. Phys. 15, 2013, 16624-14633.
[4] Kawada, S., Kodama, E., Sato, K., Ogawa, S., Watanabe, M., Okubo, H. and Sasaki, S. Surf. Interface Anal. 51, 2019, 17-20.
[5] Kawada, S. and Sasaki, S. Tribol. Online. 13, 2018, 152-156.

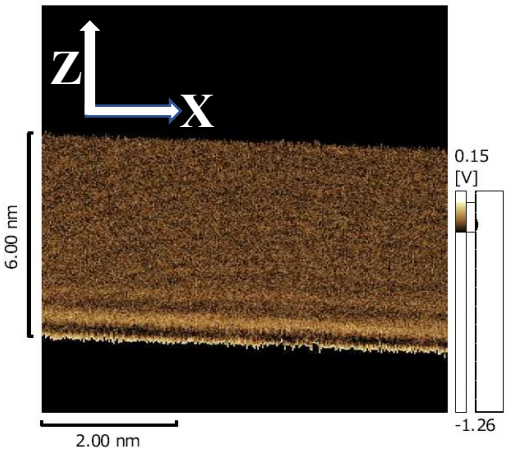

Fig. 1 Z-X images of the force curve of [BMIM][DCN]