

Possibility of Ionic liquid based on Bis(fluorosulfonyl)imide (FSI) for Lithium ion Battery Application

Manbu Kikuta^a, Michiyuki Kono^a, Masashi Ishikawa^b

^a Dai-ichi Kogyo Seiyaku Co., Ltd.,
Electronic Materials R&D Department,
5, Oogawara-cho, Kisshoin, Minami-ku,
Kyoto 601-8391 Japan

^b Faculty of Chemistry, Materials and Bioengineering,
Kansai University
3-3-35 Yamate-cho, Suita 564-8680, Japan

Introduction

The expectation and development of lithium ion secondary battery is growing-up for the application in large energy storage systems by having high energy density and high power density. However, the curious trouble such as fire was also observed when the cell was taken under abnormal condition by mechanical stress or overcharge etc. Thus, the requirements for safety are strongly emphasizing.

To obtain the safety, reliability, and higher energy density for lithium battery, we reported the solid polymer electrolyte working at 40 degree C. at 2004 Joint International Meeting of ECS.

Ambient temperature ionic liquids are expected as safe electrolyte due to the specific property as non-volatility, extreme-high flame resistance, and high ionic conductivity. Recently, the reports of ionic liquid evaluation for battery application are increasing, but there is a few kind of ionic liquid work as electrolyte in the cell. Among various kinds of ionic liquid, bis(fluorosulfonyl)imide (FSI) based ionic liquid shows specifically lower viscosity, lower melting point and higher ionic conductivity.¹⁾, as shown in Figs. 1 and 2.

Ishikawa et al. investigated the electrochemical properties of ambient temperature ionic liquids composed of FSI anion and EMI or *N*-methyl-*N*-propylpyrrolidinium cation.^{2,3)} The ionic liquid electrolyte, 1-ethyl-3-methylimidazolium (EMI) -FSI containing a Li salt without any additives provides a theoretical reversible capacity for graphitized negative electrode upon cycling.

Matsumoto et al. reported good cycleability of Li/LiCoO₂ cell with FSI based ionic liquid electrolyte.⁴⁾

Experimental

The chemical structure of ammonium cation and phosphonium cation was evaluated by the calculation of the quantum chemistry using ab-initio method.

Several kinds of ionic liquid consisting of FSI anion were synthesized by high purity process. These ionic liquids contain less than 10 ppm moisture and less than 2 ppm halide and alkali-metal as impurities.

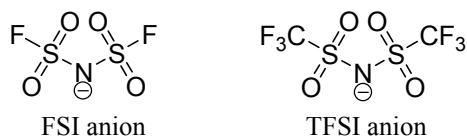


Fig.1. Chemical structure of FSI and TFSI anion.

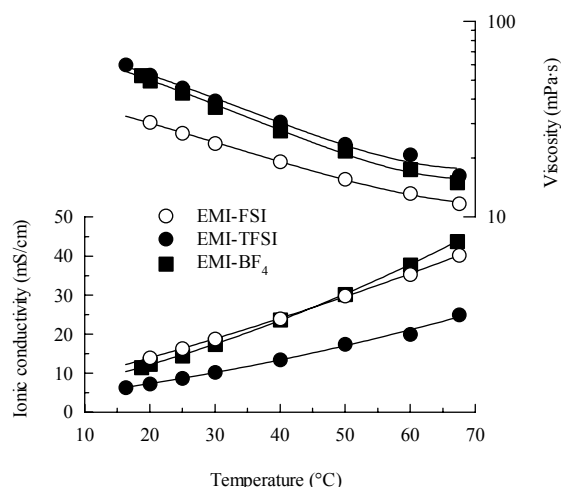


Fig.2. Ionic conductivity and viscosity of FSI-IL

Results

From the result of quantum chemistry calculation, FSI anion seems to be stable at the potential of Li/Li⁺ because of having Lower HOMO than that of lithium. Oxidation resistance from LUMO level of the cation molecule seems to correlate with the result of the potential window from CV measurement of ionic liquid.

EMI-FSI containing LiTFSI showed good cycleability when a graphite anode used. By replacing EMI-FSI to EMI-TFSI, this system didn't show any cycleability.

Specific phenomena of a novel ionic liquid based on FSI anion will be discussed in detail.

Acknowledgements

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Reference

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