Impurities Effect on Lithium Cycling Efficiency in Room Temperature Ionic Liquids (RTILs) Electrolytes

Hikari Sakaebe, Hajime Matsumoto, and Kuniaki Tatsumi
Research Institute for Ubiquitous Energy Devices,
National Institute of Advanced Industrial Science and Technology (AIST)
1-8-31 Midorigaoka, Ikeda, Osaka 563-8577, Japan

Room Temperature Ionic Liquid (RTIL) recently has attracted many researchers as a new solvent for electrochemical process. Due to the extremely low vapor pressure and flame resistant properties, RTIL could be a candidate electrolyte for the lithium batteries with improved safety in the next generation.

One of the authors, Matsumoto, discovered the useful series with asymmetric quaternary ammonium cations, which enabled the reversible plating/stripping of lithium metal[1], and among them, authors have found a quite promising RTIL, N-methyl-N-propylpiperidinium bis(trifluoromethanesulfonyl)imide (PP13-TFSI, see Fig.1). This PP13-TFSI showed the excellent properties in Li/$LiCoO_2$ cell [2]. Recently authors have investigated the cycling efficiency of Li metal in PP13-TFSI containing electrolyte [3], and the results were very sensitive against the experimental conditions. PP13-TFSI used was thoughly purified, however, the surface electrolyte interface (SEI) layer of Li metal anode could be quite easily affected by the trace amount of impurities.

In this paper, a certain amount of halogen species which could be originated from the raw material in the preparation process was added to PP13-TFSI electrolyte, and electrochemical properties of Li metal anode is investigated.

PP13-TFSI was prepared according to the report [2] and it was confirmed that Br was under detectable level and that the water content was below 15 ppm. Then the certain amount of vacuum-dried PP13-Br and then 10 wt% of supporting electrolyte LiTFSI which was dried sepalately in advance were added to the PP13-TFSI. Conventional two-electrode cell and three-electrode cell were used for the electrochemical measurements. Working electrode was polished Ni.metal for cycling efficiency measurement. For counter and reference electrode, Li metal was used. Galvanostatic plating - stripping was conducted at 0.01 – 0.1 mA cm^{-2}. The cycling efficiency was evaluated by two means; one technique is to plate and strip the same amount of lithium, and the other is to estimate the figure of merit (F. O. M.) as an average of Coulombic efficiency [4]. The former technique provided a large variation in efficiency in each cycle. The detailed results of the addition of impurities will be presented at the meeting site.

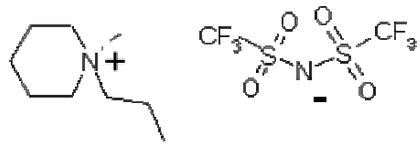

Fig. 1 PP13-TFSI structure.

ACKNOWLEDGEMENT

This work was supported by R&D project for Li batteries by METI and NEDO.

REFERENCES

[1] H. Matsumoto, *et al*., *Molten Salts XII*, edited by P.C.Trulove *et al*., ECS, Pennington, NJ, 2000, p.186

[2] H. Sakaebe, H. Matsumoto., *Electrochem. Commun.*, **5,** 599 (2003).

[3] H. Sakaebe, et al., Abstract No. 359, 12th International Meeting on Lithium Batteries, Nara, Japan, June 27-July 2, (2004).

[4] J.-I. Yamaki and S.-I. Tobishima, *Handbook of Battery Materials*, J. O. Besenhard,Editor, p. 339, Wiley-VCH, Weinheim (1999).