Interferometry Study on Li Battery Electrode Material

Kei Nishikawa, Yasuhiro Fukunaka, Tetsuo Sakka*, Yukio H. Ogata* and J. Robert Selman**

Graduate School of Energy Science, Kyoto University, Yoshidahonnmachi, Sakyo-ku, Kyoto, 606-8501, Japan

** Institute of Advanced Energy, Kyoto Univeristy*

***Center for Electrochemical Science and Engineering, Illinois Institute of Technology*

Li ion battery is now widely used as power sources of mobile electronic devices. It is also expected for the power supply of the electronic vehicles. However, a new negative electrode material must be developed, because the capacity of graphite material as the negative electrode has almost reached the theoretical limit.

Li metal is an attractive candidate for the negative electrode, because it has highest energy density. The dendrite growth of Li metal during the charging operation however, introduces a fatal problem. Generally speaking, the dendritic growth of metal is influenced by the ionic mass transfer phenomena. Therefore, it is indispensable to understand the coupling phenomena between ionic mass transfer phenomena and the dendritic growth of Li metal. On the other hand, Sn based alloys provide promising materials for the negative electrode. Many researchers have focused on the cycle efficiency and the mass transfer inside the electrode materials. The ionic mass transfer in the electrolyte has not been examined.

In this study, the mutual diffusion coefficients of $LiClO_4$ and $LiPF_6$ in PC electrolyte are measured by the Moiré Pattern method. However, the ionic mass transfer rate during the electrodeposition or electrochemical dissolution of Li metal (or charging to Sn based alloy) was in-situ measured by the holographic interferometry technique. The horizontal installed working electrode is facing downward in order to restrict the natural convection induced by the electrodeposition.

Figure 1 shows the transient behaviour of the electrode surface concentration accompanied with the electrodeposition of Li metal (circle) and insertion of Li^+ into Ni-Sn alloy (triangle)in the $LiClO_4$-PC electrolyte solution.

In case of the electrodeposition of Li Metal, "incubation period" explicitly appears before the interference fringes starts to shift. This phenomena may be caused by the formation of SEI layer on the electrodeposited Li metal surface.

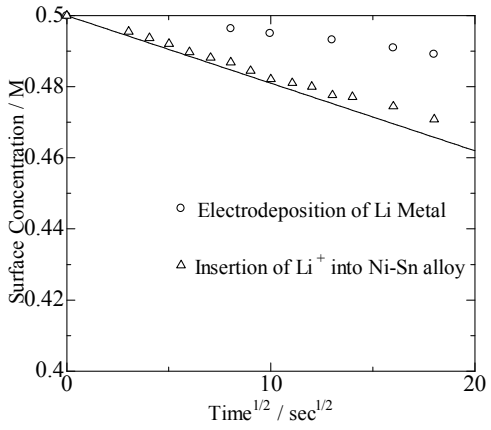

Figure 1: Transient Behavior of Surface Concentration of Li^+ Ion (at 0.5mA/cm^2)