Fabrication of All-Solid-State Lithium Batteries Using *in-Situ* Formed Electrode

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All-solid-state lithium battery is one of the candidates for next generation batteries, and a crucial problem to improve its performance will be the reduction of charge-transfer resistance at electrode/solid-electrolyte interface. We previously developed the partial conversion of solid electrolyte (lithium aluminum titanium phosphate, LATP) into electrode active material by electrochemical irreversible Li^+ insertion reaction, and found that charge transfer resistance at the *in-situ* formed electrode/LATP interface was small probably because of well-connected interface without any mutual diffusion layer.[1] However, the growth amount of the *in-situ* formed electrode was extremely small at room temperature and the growth area was limited only around the LATP/current collector interface. In this work, *in-situ* formed electrodes were grown at higher temperatures. These conditions are supposed to be effective to increase the growth amount of *in-situ* formed electrode because the electronic conductivity increases at higher temperatures.

A LATP sheet with a thickness of 150 μm (OHARA Inc.) was used as the solid electrolyte. Lithium phosphorus oxynitride glass electrolyte (LiPON) was deposited on one side of the LATP sheet by RF magnetron sputtering. Thin film of Li was deposited on the LiPON film by vacuum evaporation. The opposite side of the LATP sheet was covered with Au film. Eventually, a Li/LiPON/LATP/Au multilayer was fabricated. Electrochemical properties of the resultant cell were measured by cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS), and charge-discharge measurements.

In the CV measurements of the Li/LiPON/LATP/Au cell, a couple of redox peaks were observed at 2.35 V (vs. Li^+/Li) as shown in Figure, which was in good agreement with the previous work.[1] Initial discharge capacity at 25 °C was 45 mC/cm^2, which increased with increasing the reaction temperature. At 100 °C, the capacity reached to 1250 mC/cm^2, ca. 27 times larger value than that at 25 °C. This result suggests that the *in-situ* formed electrode grow deeply inside the LATP sheet at higher temperatures. Electrochemical properties of those batteries will be discussed in the poster session.

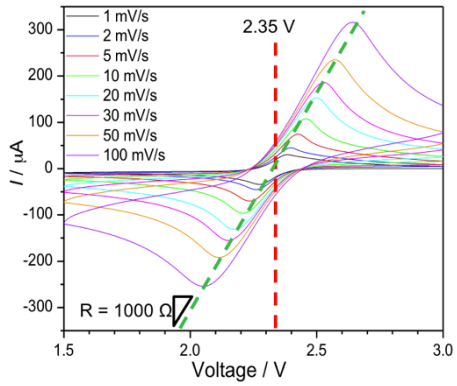

Figure. Cyclic voltamograms of a Li/LiPON/LATP/Au cell from 3.0 to 1.5 V at 25 ˚C.

References:

[1] Y. Amiki, F. Sagane, K. Yamamoto, T. Hirayama, M. Sudoh, M. Motoyama, Y. Iriyama, *J. Power Sources* 241 (2013) 583–588.