Ion Transport Behavior of Electrolyte Solution within Pores in Anodic Porous Alumina Membranes as Model of Composite Electrode

Tomokazu Fukutsuka, Kohei Koyamada, Taiga Yamada, Yitong Zhang, Shohei Maruyama, Yuto Miyahara, Kohei Miyazaki, and Takeshi Abe
Graduate School of Engineering, Kyoto University, Nishikyo-ku, Kyoto 615-8510, Japan

E-mail: fuku@elech.kuic.kyoto-u.ac.jp

Lithium-ion batteries (LIBs) are desired as the power sources in electronic vehicles (EVs). Not only high energy density but also rapid charge–discharge rate should be achieved for LIBs for EVs-use. In the present LIBs for EVs-use, rapid charge–discharge rate is given priority over high energy density. Hence, the cursing distance of EVs is not sufficient to replace the gasoline automobile by EVs.

To enhance the energy density of LIBs, the density and the thickness of the composite electrode layer must be increased. High density and large thickness cause the large internal resistance derived from ion (lithium ion and counter anion) transport in composite electrodes. Therefore, suppression of the reduction in the internal resistance in composite electrodes with high density and large thickness must be considered. Composite electrodes in LIBs have various sizes of pores (macro, meso, and micro). Therefore, ion transport behavior of electrolyte solution within the pores of composite electrode should be clarified basically.

In this study, as a suitable model that can reflect the ion transport in the composite electrodes, we focused on the anodic porous alumina (APA) membranes that have ordered through-holes with nanometer-sized diameter and one hundred micrometer thickness [1]. Ion transport behavior through the APA membrane was investigated by ac impedance spectroscopy by using a four-electrode cell [2].

Figure 1 shows the specific ion conductivity of 1 mol dm^{-3} $LiClO_4$/EC+DEC(1:1) in the pores of APA membranes. The specific ion conductivity was calculated from structural parameters obtained from FE-SEM observation. From Fig. 1, the specific ion conductivities inside the pores were an order of magnitude smaller than that of the bulk electrolyte solution. This result indicated that ion transport inside composite electrodes would be smaller than bulk electrolyte solution. The details will be reported at the meeting.

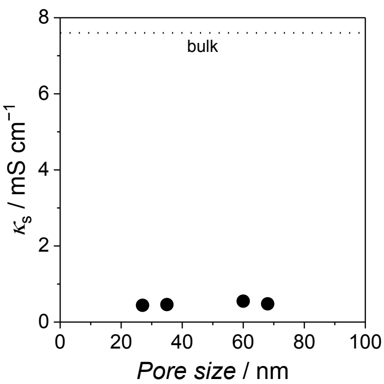

Figure 1. Specific ion conductivites of $LiClO_4$/EC+DEC within the pores of APA membrans.

This research was supported by JST, CREST.

References:

[1] H. Masuda and K. Fukuda, Science, 268 (1995) 1466–1468.
[2] T. Fukutsuka, K. Koyamada, S. Maruyama, K. Miyazaki, T. Abe, Electrochimica Acta, 199 (2016) 380–387.