Influence of surface film on the lithium-ion intercalation sites at highly oriented pyrolytic graphite

Akane Inoo, Tomokazu Fukutsuka, Yuto Miyahara, Kohei Miyazaki and Takeshi Abe
Department of Energy and Hydrocarbon Chemistry, Graduate School of Engineering,
Kyoto University, Nishikyo-ku, Kyoto 615-8510, Japan
E-mail: akane.inoo@elech.kuic.kyoto-u.ac.jp

To elucidate the influence of surface film on the lithium-ion intercalation sites at highly oriented pyrolytic graphite (HOPG), we investigated the relationship between electric double layer capacitances (C), which correlate closely with fraction of edge orientations[1], and charge-transfer resistances for lithium-ion intercalation (R_{ct}) after formation of solid electrolyte interphase (SEI) films.

Using HOPG as a working electrode, we calculated C from cyclic voltammograms in 1.0 mol dm^{-3} KCl(*aq*), and derived R_{ct} from the electrochemical impedance spectra in a solution of ethylene carbonate (EC) and diethyl carbonate (DEC) (1 : 1 volume ratio) containing 1.0 mol dm^{-3} $LiClO_4$ with or without the addition of 3 wt% VC.

Figure 1 shows the linear relationship between $1/R_{ct}$ and C. In addition, the slope of the straight line of with VC was smaller than that without VC. Based on the Arrhenius equation, R_{ct} mainly depends on the activation energy (E_a) and the frequency factor (A). Since E_a was unchanged by VC-derived SEI[2], the decrease in A corresponds to the decrease in the number of insertion sites. This indicates the influence of the SEI component on the number of lithium-ion insertion sites.

References:

[1] M. T. McDermott et al., *J. Phys. Chem.*, **96** (1992) 3124.
[2] Y. Yamada et al., *Langmuir*, **25** (2009) 12766.

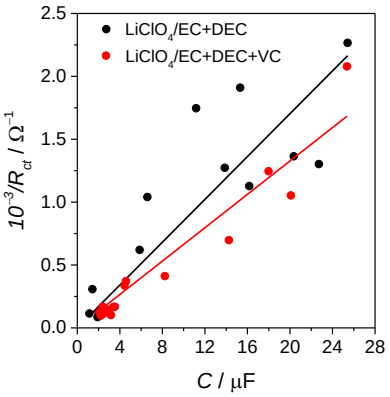

Fig. 1. Correlation between C and R_{ct} at HOPG.