

# REACTION DISTRIBUTION IN COMPOSITE ELECTRODES OF LIB

Zempachi Ogumi<sup>a</sup>, Hajime Arai<sup>a</sup>, Yuki Orikasa<sup>b</sup>, Yoshiharu Uchimoto<sup>b</sup>

<sup>a</sup> Office of Society-Academia Collaboration for Innovation, Kyoto University,  
Gokasho, Uji, Kyoto, 611-0011 Japan

<sup>b</sup> Graduate School of Human and Environmental Studies, Kyoto University,  
Sakyo-ku, Kyoto, 606-8501 Japan

ogumi@scl.kyoto-u.ac.jp

Various kinds of application-oriented lithium ion batteries (LIBs) are produced in large scale. Uniform reaction inside the battery leads to the maximum performance of the battery. It is difficult so far, however, to observe phenomena and examine their distribution inside *operando* LIBs. High-energy X-ray from storage ring and neutron beam can penetrate the depth of LIB and clarify reactions and their distribution inside LIB even covered with metal case. The authors devised some new technology to examine reactions inside LIB using SPring-8 beam line[1-3].

Reaction distribution has a hierarchy; crystallite, primary particle of polycrystalline, secondary particle, one dimensional depth distribution of composite electrode, two dimensional facial distribution of composite electrode, battery-to-battery in battery pack, and module-to-module in battery system.

We focus on the distribution through the depth of LiCoO<sub>2</sub> (LCO), LiNi<sub>1/3</sub>Mn<sub>1/3</sub>Co<sub>1/3</sub>O<sub>2</sub> (NMC), and LiFePO<sub>4</sub> (LFP). Space sensitive X-ray absorption spectroscopy and X-ray diffraction revealed that the distribution is more remarkable for the composite of low porosity than for the one of high porosity[4, 5]. Charge and discharge at high rate causes large reaction distribution through the depth of composite electrode. The distribution is relaxed under potential resting or open circuit for the composite electrode for LCO and NMC active materials but not for LFP. This different behavior is ascribed to the potential change depending on lithium content of the materials. A local cell formed inside the composite electrode relaxes the distribution. Very flat potential change with lithium content of LFP gives little motive force for relaxation of the distribution.

This work was carried out as a part of Research and Development Initiative for Scientific Innovation of New Generation Batteries (RISING project) financially supported by New Energy and Industrial Technology Development Organization (NEDO).

Reference to a journal publication:

- [1] Y. Orikasa, H. Arai, Y. Uchimoto, Z. Ogumi et. al., J. Am. Chem. Soc., 2013, **135**, 5497.
- [2] D. Takamatsu, Y. Orikasa, H. Arai, Y. Uchimoto, Z. Ogumi et al., Angew. Chem. Int. Ed., 2012, **51**, 11597.
- [3] H. Tanida, Y. Orikasa, H. Arai, Y. Uchimoto, Z. Ogumi et. al., J. Synchrotron Rad., 2014, **21**, 268.
- [4] H. Murayama, H. Arai, Y. Uchimoto, Z. Ogumi et. al., J. Phys. Chem. C, 2014, **118**, 20750.
- [5] M. Katayama, H. Arai, Y. Uchimoto, Z. Ogumi et. al., J. Power Sources, 2014, **269**, 994.