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Operando μSR and SANS Experiments on Battery Materials

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To address carbon dioxide emissions, battery performance must be improved. Lithium-ion batteries (LIBs) dominate the market, but their limited and geographically concentrated resources have prompted research into sodium-ion batteries (NIB) to replace LIBs [1]. At J-PARC, we employed positive muon spin relaxation (μ^+SR) [2] and small-angle neutron scattering (SANS) [3] in hard carbon, which is a candidate for anodes in NIBs, to measure self-diffusion coefficients (D^J) and structural change, respectively. Our investigation of hard carbon revealed a sodium ion D^J of 2.5×10^{-11} cm$^2/s$—lower than lithium in graphite but with small activation energy. The operando cells have developed, and we compared diffusion in Li_xCoO_2 and Na_xCoO_2 systems under operando measurements, finding distinct concentration-dependent behaviors: lithium showed steep changes near x = 1, while sodium decreased linearly with concentration [4,5]. In the presentation, we will also discuss the results of operando SNAS measurements on hard carbon.

[1] N. Yabuuchi *et al.*, Chem. Rev. **114**, 11636 (2014).
[2] K. Ohishi *et al.*, ACS Phys. Chem. Au 2, **98**, 107 (2021).
[3] K. Ohishi *et al.*, J. Phys.: Conf. Ser. **2462**, 0120048 (2023).
[4] K. Ohishi *et al.*, ACS Appl. Energy Mater. **5**, 12538-12544 (2022).
[5] K. Ohishi *et al.*, ACS Appl. Energy Mater. **6**, 8111-8119 (2023).

Email

k_ohishi@cross.or.jp

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JST-GteX, JSPS KAKENHI

Supervisors Name

Supervisors Email

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Primary author: OHISHI, Kazuki (Comprehensive Research Organization for Science and Society (CROSS))

Co-authors: KODA, Akihiro (KEK); Dr IGARASHI, Daisuke (Tokyo University of Science); UMEGAKI, Izumi (KEK); NAKAMURA, Jumpei G. (KEK/J-PARC center); SUGIYAMA, Jun (CROSS Neutron Science and Technology Center); Dr HIROI, Kosuek (Japan Atomic Energy Agency); Dr NAKAMOTO, Kosuke (Tokyo University of Science); Prof. MÅNSSON, Martin (KTH); Prof. TATARA, Ryoichi (Yokohama National University); Dr TAKATA, Shin-ichi (Japan Atomic Energy Agency); Prof. KOMABA, Shinichi (Tokyo University of Science); NISHIMURA, Shoichiro (KEK IMSS); Mr MORIKAWA, Toshiaki (Comprehensive Research Organization for Science and Society (CROSS)); Dr KAWAMURA, Yukihiko (Comprehensive Research Organization for Science and Society (CROSS))

Presenter: OHISHI, Kazuki (Comprehensive Research Organization for Science and Society (CROSS))

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