

Operando μ SR on Li- and Na-ion batteries in J-PARC

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A self-diffusion coefficient (D^J) of Li^+ (Na^+) is an intrinsic property of Li^+ -ion (Na^+ -ion) battery materials and is detected with a muon spin rotation and relaxation (μ SR) technique through the observation of a fluctuating nuclear magnetic field formed by Li^+ (Na^+) ions [1].

Due to the high counting rate of μ SR in Muon Scientific Establishment (MUSE) of J-PARC, which was achieved by the increase in the proton current and the improvement of detecting systems, we can observe the internal nuclear magnetic field in the battery materials during a charge and discharge reaction.

In fact, using a special electrochemical half-cell (Fig.1), D^J has been measured with an operando manner by μ SR [2-3]. However, in our initial attempts, the operando μ SR measurements were performed only at room temperature. In order to study the temperature dependence of D^J , we have designed a temperature control system for the operando μ SR cell at temperatures between 0 and 80 °C.

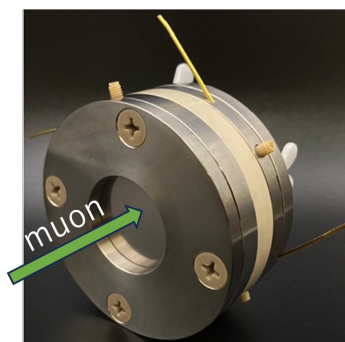


Fig. 1 An operando μ SR cell.

[1] J. Sugiyama et al., Phys. Rev. Lett. **103**, 147601 (2009).

[2] K. Ohishi, D. Igarashi, R. Tatara, I. Umegaki, A. Koda, S. Komaba, J. Sugiyama, ACS Applied Energy Materials, **5**, 10, (2022).

[3] K. Ohishi, D. Igarashi, R. Tatara, I. Umegaki, J. G. Nakamura, A. Koda, M. Månsson, S. Komaba, J. Sugiyama, ACS Applied Energy Materials, **6**, 15, (2023).