Contribution ID: **106** Type: **Oral**

Non-destructive operando measurements of muonic x-rays on Li-ion battery

Monday, 29 August 2022 16:20 (20 minutes)

We have developed an elemental analysis technique with muonic x-ray on a Li-ion battery, taking advantages of muon and muonic x-rays, that is, accessibility of negative muons and high energy of muonic x-rays[1,2]. Especially, intense negative muon with low momentum at J-PARC enables us to investigate electrodes in Li-ion battery. There is no non-destructive method to observe Li directly deep inside the Li-ion battery. Elemental analysis with muonic x-rays has great advantages for that.

We have recently performed operando measurements of muonic x-rays on aLi-ion battery at J-PARC for the first time. By this technique, we have demonstrated the intercalation of Li in a cathode during charging and discharging. Also, we found that we can detect metallic Li deposition on a negative electrode using a difference in capture rates between metallic Li and C_6Li[3]. Using this technique, observing an increase in the metallic Li deposition during high-rate charge/discharge cycles is expected to be realized.

We will show the progress in operando measurements of muonic x-rays to study Li-ion batteries at J-PARC.

[1] M. Tampo et al., Proceedings of MuSR2014, JPS Conf. Proc.8, 036016,(2015).
[2] I. Umegaki et al.,"Detection of Li in Li-ion battery electrodes by muonic x-ray elemental analysis", MuSR2017.
[3] I. Umegaki et al., Analytical Chemistry, 92, 12,8194-8200 (2020).

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Session Classification: Oral contributions

Track Classification: Muonic x-rays