Contribution ID: **52** Type: **Contributed**

Lithium-Ion Batteries monitored by Neutrons

Tuesday 19 July 2016 09:30 (20 minutes)

Powering innumerable portable devices lithium-ion batteries are part of our everyday life. An increasing number of applications related to electromobility and energy storage calls for further improvements of their life span, energy/power density and rate capability. But still some of the processes inside lithium-ion batteries are not understood completely. Therefore single cells or even integrated batteries have to be investigated under real operating conditions to unravel details occurring in the millimetre to micrometre domain and reaching down to a nanometre or even atomic length scale. Neutrons offer a capability to conduct in operando investigations on standard size Li-ion cells. Light elements like lithium and other cations may be traced during intercalation and deintercalation providing information about structural changes and phase transitions in electrode materials. Neutrons are sensitive for different cations, e.g. they allow to follow the substitution of Li by Ni atoms in the structure of cathode materials [1]. Neutron imaging and spatially resolved diffraction experiments pointed out possible inhomogenities of the state of charge inside 18650-type Li-Ion cells. Such inhomogeneities of the lithium concentration inside the anode for fully charged cells were found and could be quantified by spatially resolved neutron diffraction on a macroscopic length scale [2, 3]. Here a correlation between the cell design and the lithiation state of the graphitic anode has been found. Applying wavelength dependent imaging techniques enables to optimize contrast and transmission of a given sample and to reduce beam hardening artefacts during a tomographic reconstruction, which are present for a polychromatic neutron beam. The wavelength dependent neutron transmission signal is sensitive for Bragg edges of the different crystallographic phases occurring inside Li-ion cells. Given the necessary wavelength resolution this imaging technique might provide information on the homogeneity of the state of charge inside an operating cell similar to the results gained by spatially resolved neutron diffraction.

Findings based on a combination of electrochemical cell characterization, neutron imaging and scattering techniques will be presented. Obtained results will be discussed in terms of their influence for the future design of Li-ion cells, for example with respect to the cell geometry (tab positions) and the cell balancing.

[1] O. Dolotko, A. Senyshyn, M.J. Mühlbauer, K. Nikolowski, H. Ehrenberg, Journal of Power Sources, 245 197-203 (2014).

[2] A. Senyshyn, M.J. Mühlbauer, O. Dolotko, M. Hofmann, T. Pirling, H. Ehrenberg, Journal of Power Sources 245 678-683 (2014).

[3] A. Senyshyn, M.J. Mühlbauer, O. Dolotko, M. Hofmann, H. Ehrenberg, Nature Scientific Reports, 5, 18380 (2015), doi: 10.1038/srep18380.

Author: MUEHLBAUER, Martin (Helmholtz Institute Ulm (HIU))

Co-authors: SENYSHYN, Anatoliy (Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München (TUM)); Prof. EHRENBERG, Helmut (KIT); HOFMANN, Michael (Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München (TUM)); Dr KNAPP, Michael (KIT, IAM-ESS); Dr DOLOTKO, Oleksandr (Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München (TUM),)

Presenter: MUEHLBAUER, Martin (Helmholtz Institute Ulm (HIU))

Session Classification: Session III: Batteries 1 (Chair: Michael Hofmann)

Track Classification: Energy storage & transformation