

Characterisation of Spinel-Cathode Lithium Battery Materials

Background

A new generation of lithium battery materials is currently developed. Promising candidates for the cathode side are lithium-nickel-manganese spinel compounds with polycrystalline structure. A scanning electron microscope (SEM) especially when combined with a focused ion beam in a FIB/SEM instrument can deliver valuable information about the defect structure of the material. To gain this information the ion channelling phenomena as well as electron backscattered diffraction (EBSD) can be used. Furthermore, the FIB machine allows the usage of the so-called slicing-view or FIB tomography method, which allows to determine the three-dimensional morphology of the sample. In this master thesis, FIB-tomography will be used to determine the porosity of the new lithium-nickel-manganese spinel material. The porosity is a very important application-related parameter as any empty volumes affects the long-term property of the battery.

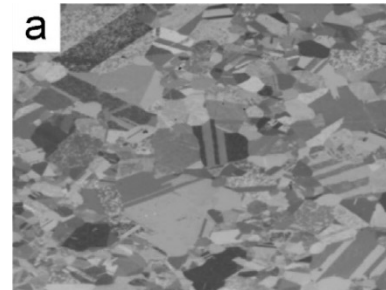


Fig. 1 Ion channelling contrast electron micrographs of pure Ni [1].

Aim

The aim of the proposed master thesis is to determine the porosity of differently synthesised cathode materials, also at different cycle stages (as cycle the charge and discharge process of the battery is mend). Quantitative information about the polycrystalline structure and porosity of the samples will allow better understanding of the mechanisms behind synthetisation and aging of the battery material.

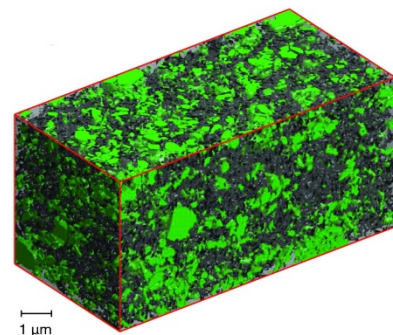


Fig. 2 Visualization of a $5 \times 5 \times 10 \mu\text{m}^3$ segment of a LiFePO_4 cathode. Carbon black: grey; LiFePO_4 grains: green; pores: semi-transparent [2].

Work plan

- introduction to electron microscopes
- introduction to the lithium battery
- specialised introduction to the focused ion beam
- sample preparation for FIB/SEM
- autonomous data acquisition with the FIB/SEM
- post processing of the acquired data with specialised programs

Requirements

- good physical understanding
- basic chemical understanding
- high interest in experimental work with a FIB/SEM
- enjoying own scientific work in our international team

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[1] S. Suarez, et.al. Materials Science & Engineering A 587 (2013) 381–386

[2] M. Ender, et.al. J. Electrochem. Soc. 2012 volume 159, issue 7, A972