Institut für Angewandte Materialien
Elektrochemische Technologien
Adenauerring 20 b
76131 Karlsruhe

Master thesis

In-Situ Investigation of Cycling Induced Mechanical Failure in Commercial Lithium-Ion-Batteries

Research area

☒ Batteries
☐ Fuel cells and electrolysis
☐ Electrocatalysis

Alignment

☒ Experimental
☒ Electrical Characterization
☐ Material analysis
☒ Development of measurement technology
☐ Modeling
☐ Simulation
☒ Literature Research

Course of study

☒ Electrical Engineering and IT
☒ Material Science
☒ Mechanical Engineering
☐ Chemical Engineering
☒ Physics
☐ Technical Mathematics

Language

☒ English
☒ German

Starting date

As soon as possible

Contact person

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Motivation

Sustainable energy supply requires not only the use of renewable energies, but also the storage and short-term availability of energy in various applications. The optimization of electrochemical energy storage systems such as Li-ion batteries (LiB) in terms of capacity, power density and service life is therefore a current research topic in science and industry. Germany wants to establish itself as a center of excellence for the production of high-performance battery cells. Cylindrical cells have gained more and more relevance in the electric vehicle and power tool sector due to increased safety and handleability compared to pouch cells. However, inhomogeneities of the jelly roll and cycling induced mechanical stresses can lead to premature failure due to deformation of the jelly roll inside the cylindrical housing. Understanding the effects leading up to failure and predicting or preventing such events are critical for secure use of high-performance storage applications.

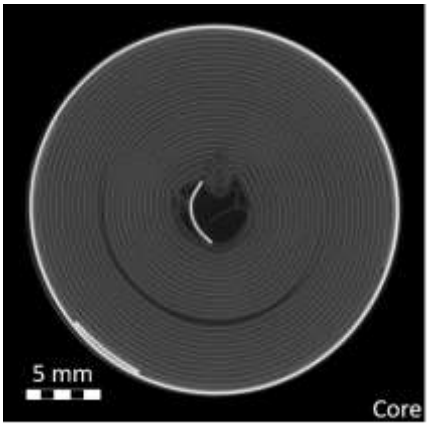

Figure 1: Slice taken from x-ray tomography of a cylindrical cell showing mechanical failure in the cell core

Your Task:

Utilizing various analytical tools available at IAM-ET such as micro X-ray tomography (µCT) to observe internal cell damage without opening the housing as well as electrochemical impedance spectroscopy (EIS) to characterize changes in battery behavior during cycling in order to gain an increased understanding of mechanically induced degradation and failure behavior of commercial Lithium-ion-Batteries.

- Cyclic Aging of commercial cylindrical cells to induce degradation
- Intermittent analysis of internal mechanical deformation or failure using µCT
- Tracking of cell impedance via EIS
- Correlation of electrode or jelly roll deformation to battery behavior and capacity fade
- Documentation of results and preparation of two presentations

Application

We offer a lively atmosphere and the opportunity to work in an interdisciplinary team on an innovative topic. We expect an independent attitude and the motivation to learn and understand a fresh topic. If you are interested in working with us or have any questions, please contact Adrian Lindner with a short introduction.

Prof. Dr.-Ing. Ulrike Krewer and Dr.-Ing. Wolfgang Menesklou