Priority Programme 1473: „Materials with New Design for Improved Lithium Ion Batteries – WeNDeLIB“

„Thermodynamics and kinetics of high capacity anode materials at elevated temperatures“

Subproject 1 “Development of ‘elevated temperature’ electrochemical cell systems with nanostructures anode materials and their electrochemical and physical characterization”

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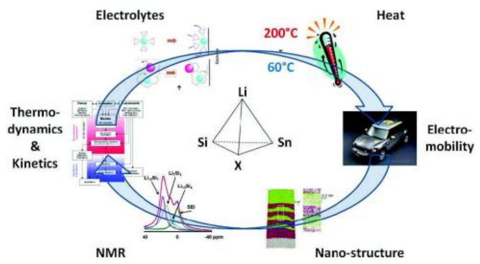

Motivation

Li-ion batteries are one of the most promising systems for mobile energy storage. A lot of cell systems are already established and are commercially available. Nevertheless, there are still a lot of improvements necessary for daily applications.

Current battery systems, e.g. electro vehicles, need to be cooled by a complex temperature management system because the majority of organic solvent and gel based electrolytes in Li-ion batteries is instable above 60°C. Therefore, the development of a cell system at elevated temperatures is of great interest.

Mostly, the elements of the 4^{th} main group are considered as active materials in negative electrodes. Although, carbon based anodes have been well explored, silicon and tin are potential candidates due to their high specific energy density of 3570 mAh/g and 990 mAh/g, respectively.

Experimental

The topic of this subproject is the investigation of high capacity anode materials and cell designs at elevated temperatures. The focus of the research is the detailed study of the thermodynamics and kinetics during the lithiation and delithiation process. The reaction mechanism of the bulk electrode, the structural changes and molecular particle phases are the challenging issues.

So far, nano silicon particles are implemented in a carbon matrix to increase the cycling performance and overcome the lost of conductivity due to the large volume expansion of the silicon particles during the lithiation process. A standard electrode composition and preparation is already established, further investigated and the cell setup for elevated temperatures is developed.

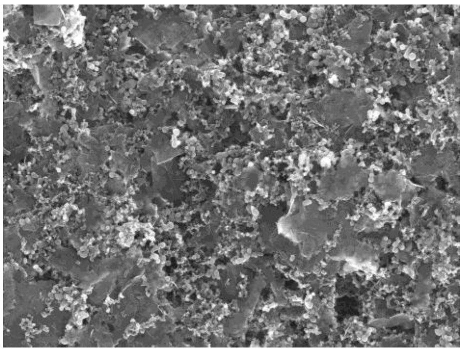

Figure 1: SEM picture of Si/C composite electrode

We use *in-situ* and *ex-situ* methods to investigate kinetic effects and phase changes within the material. The set of methods compromises cycling test at certain c-rates, impedance spectroscopy, cyclic voltammetry for half and full cells, as well as SEM, XRD, NMR for *ante* and *post mortem* analysis.

In addition, we develope a cell design and composition to get an insight into the local structures within the particles and components for *in-situ* NMR measurements (Figure 2).

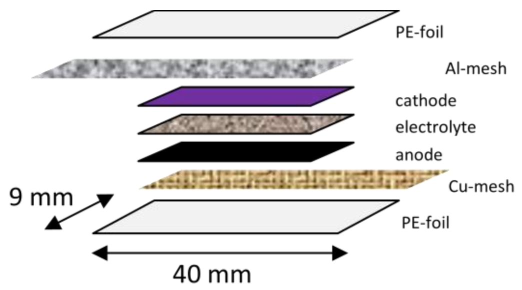

Figure 2: *In-situ* cell design