Karlsruhe Institute of Technology

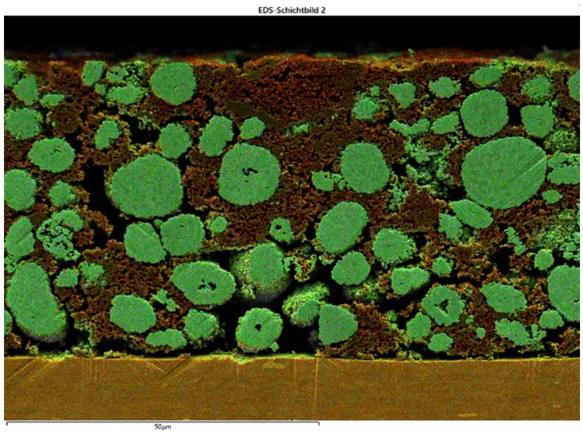
Institute for Applied Materials

Investigation of the Time-Dependent Addition of Acids for Water-Based LIB Cathodes

Introduction:

In today's energy policy context, electrochemical storage devices such as lithium-ion batteries (LIBs) play an important and promising role in meeting the sharply increasing demand for electricity and mitigate the intermittent nature of solar and wind energy. Modern LIBs consist of an active material, a conductive carbon, and a polymeric binder, which are mixed into a slurry and then applied to a current collector foil. Current manufacturing processes use the teratogenic solvent N-methyl-2-pyrrolidone (NMP), a polar aprotic solvent, to dissolve the binder and ensure that the slurry is workable. However, the aqueous processing of cathodes for LIBs allows the removal of NMP towards sustainable and environmentally friendly production.

Content:



The thesis at the Institute of Applied Materials - Energy Storage Systems aims to gain a deeper understanding of the intermolecular relationships between the binder systems and the active materials of aqueous processed cathodes. In the first part it shall be elucidated how a novel binder system is distributed in the electrode at different shear rates. For this purpose, different speeds during the mixing process are investigated and the influence of mixing times on the distribution of inactive and active components at different shear stresses is investigated. Furthermore, different times of binder addition during the mixing process should be considered.

The second part deals with the interaction between water and the active material of the cathode. Indeed, the water-based processing of NMC622 presents challenges that are unusual in the field of cathode production. NMCs are oxides of so-called non-noble metals which, in contact with water, strongly alkalize the solvent and thus have unfavourable consequences for the aluminium substrate. As a result, the aluminium foil corrodes and a strong bubble formation begins. In order to suppress this, there are various research approaches such as regulating the pH of the slurry by adding acids and reducing it to moderate values. The main focus of the work is to investigate the distribution of the materials as a function of different acids and addition times and thus to gain further knowledge about the stability of the different inactive and active materials.

Both, the first and the second part include the independent production of electrodes, the construction of own test cells (coin cells), and electrochemical characterization of these. In addition, the created electrodes will be investigated with different characterization methods, such as SEM, EDX, XRD, etc.

The work is to be carried out independently. Details, such as required data, drawings etc. are be discussed with the supervisor. The scope and the processing time depend on the valid examination regulations.

Ideally, you have a background in chemistry, chemical engineering, materials science, process engineering or similar and are interested in electrode development for lithium-ion batteries. Experience in laboratory work is desirable.

If you are interested in this project or would like to have more information, please contact **André Müller** (andre.mueller@kit.edu).

Literature:

[1] W. Bauer, F. A. Çetinel, M. Müller, U. Kaufmann, *Electrochimica Acta* **2019,** 317, 112–119

[2] A. Kazzazi, D. Bresser, A. Birrozzi, J. v. Zamory, M. Hekmatfar, S. Passerini, *ACS applied materials & interfaces* **2018**, 20, 17214-17222

[3] M. Kuenzel, D. Bresser, T. Diemant, D. V. Carvalho, G.-T. Kim, R. J. Behm, S. Passerini, *ChemSusChem* **2018**, 3, 562–573