Towards more sustainable battery materials: insights into the fundamental properties of different material classes using solid-state thin-film model cells

Gennady Cherkashinin, Philipp Komissinskiy, Maximilian Mellin, René Hausbrand, Jochen Rohrer, Karsten Albe, Jan Philipp Hofmann, Wolfram Jaegermann, Lambert Alff

Institute of Materials Science, Technical University of Darmstadt

A key trend in the modern development of green energy sources such as alkali ion batteries is an increase of the energy density and the power density in order to meet the performance requirements for electromobility and regenerative energy storage. Therefore, more sustainable battery materials are required to meet the economic and environmental demands if batteries are to be implemented on a large scale.

There are different approaches how more sustainable insertion batteries may be achieved: critical elements can be substituted in a given material, materials can be substituted by other materials, or hybrid material concepts can be used. In any case, most favorable is the application of such materials in solid-state batteries which promise very high energy density combined with high stability.

At the Institute of Materials Science, TU Darmstadt, we focus on the development of advanced novel cathode materials and electrolytes for all-solid-state thin-film Li^+ and Na^+ rechargeable batteries. We investigate the fundamental properties and optimization of well-defined (model) cathode materials, solid electrolytes, and electrode/electrolyte interfaces using solid-state thin-film cells. The developed in-situ and operando approaches to study evolution of chemical composition, electronic- and crystal- structures under working conditions of the model cells with well-defined geometry allows direct correlation between the materials properties and battery performance. In our poster, we present an overview of our results on different materials and material classes such as sodium-based layered oxides and high-voltage phosphates as well as solid state electrolyte materials.