Correlative Electrochemical Strain Microscopy and Scanning Electron Microscopy on Solid State Electrolytes

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All Solid State Batteries (ASSB) are attractive candidates for future energy storage applications due to their improved safety characteristics such as inflammability. Realizing ASSBs require a fundamental understanding of the electrochemical and charge transport properties as well as interfacial performance of the solid state electrolyte. A key to improve solid state electrolytes like Lithium Aluminum Titanium Phosphate $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$ (LATP) or the garnet-type $Li_7La_3Zr_2O_{12}$ (LLZO) is to elucidate interfacial and ion transport properties at a process relevant scale, i.e. the micro- and nanometer range. In contrast to common techniques such as electrochemical impedance spectroscopy where only global information can be obtained, we combine multiple microscopy techniques to gain chemical, electrochemical as well as structural information with high spatial resolution.

In this contribution we introduce correlative electrochemical strain microscopy (ESM) and scanning electron microscopy (SEM) to investigate the relationship between microstructure and Li-ion conductivity locally on solid state electrolytes. For LATP we find significantly reduced Li-ion mobilities in secondary phase areas consisting of $AlPO_4$ as proven by means of energy-dispersive X-ray spectroscopy. The contribution of grain boundaries to the overall ionic conductivity is discussed in view of recently published impedance spectroscopy results [1]. Additionally, we point out possible electrostatic contributions to the signal formation origin of ESM on solid state electrolytes.

References:

[1] A. Mertens, S. Yu, N. Schön, D.C. Gunduz, H. Tempel, R. Schierholz, F. Hausen, H. Kungl, J. Granwehr, R.-A. Eichel, Solid State Ionics 309 (2017) 180-186