Impedance-Spectroscopic Quantification of High Bulk Ionic Conductivity in $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$ Solid Electrolyte

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Today's lithium-ion batteries use liquid electrolytes with inherently limited rate capability and safety concerns. The use of solid electrolytes might mitigate these issues, but so far, either their scalability for mass production or their ionic conductivity is not competitive. While the scalability depends on the chosen materials and the cell engineering, improving the conductivity requires a better understanding of the underlying ion transport phenomena. Impedance spectroscopy is widely applied in this regard, but distinguishing between the strongly overlapping contributions from bulk and grain boundary is challenging and often requires low temperature measurements.

In this work, we quantify the bulk and grain boundary resistance of a $Li_{1.3}Al_{0.3}Ti_{1.7}(PO_4)_3$ (LATP) solid electrolyte at temperatures up to 50 °C by a distribution of relaxation times analysis in two dimensions (2D-DRT). In combination with a microscopic analysis by scanning and transmission electron microscopy, the bulk and grain boundary ionic conductivities are determined under realistic battery operation conditions. For the bulk ionic conductivity, values up to 3 $mS \cdot cm^{-1}$ have been found. Moreover, the activation energies of the ionic transport in bulk and in the grain boundary are calculated.