Spatially resolved electrochemical characterization and chemical analysis of $Li_{6.4}Al_{0.2}La_3Zr_2O_{12}$ garnets

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Rechargeable Li-ion battery (LiB) systems based on liquid organic (polymer) electrolytes became eminently important over the last few decades. Nonetheless, they exhibit distinct safety problems and suffer from capacity losses primarily related to degradation caused by the liquid electrolyte. Therefore, current research is focusing on all solid state Li-ion battery systems to overcome this problems. Among solid electrolytes, cubic $Li_7La_3Zr_2O_{12}$ (LLZO) is one of the most promising candidates to replace its liquid counterpart[1]. This garnet-type oxide exhibits high ionic conductivity in combination with high chemical and electrochemical stability, as well as high stability against metallic lithium. However, the crucial parameters for a defined engineering of an optimized LLZO electrolyte are still under investigation.

In this contribution we report on spatially resolved electrical impedance measurements (EIS) performed on $Li_{6.4}Al_{0.2}La_3Zr_2O_{12}$.[2]. By applying Pt micro-electrodes on the samples it became possible to probe different areas of the material, allowing us to monitor highly resolved conductivity distributions. These local conductivities are compared to values from macroscopic measurements and revealed severe conductivity gradients. Locally, conductivities as high as $8 \cdot 10^{-4}$ S/cm were found compared to an overall conductivity of the pellet of $3.3 \cdot 10^{-4}$ S/cm. Hence, distinct variations in the elemental composition within one and the same sample can be supposed. Additional quantitative analysis by means of LA-ICP-MS and LA-ICP-OES lead to information on the exact local stoichiometry. Interpreting the analytical results in combination with the electrical impedance data, thus can help to receive LLZO electrolyte material with defined and reproducible properties.

[1] J. Schwenzel, V. Thangadurai, W. Weppner; J. Power Sources. 154 (2006) 232–238.

[2] A. Wachter-Welzl, R. Wagner, D. Rettenwander, S. Taibl, G. Amthauer, J. Fleig; J. Electroceramics. in press