Investigating the Li+/H+ exchange in garnet-type solid electrolytes using LIBS

Stefan Smetaczek\textsuperscript{1} Veronika Zeller\textsuperscript{1} Daniel Rettenwander\textsuperscript{2} Jürgen Fleig\textsuperscript{1} Andreas Limbeck\textsuperscript{1}

Email: stefan.smetaczek@tuwien.ac.at

1. Institute of Chemical Technologies and Analytics, TU Wien, Vienna, Austria
2. Institute for Chemistry and Technology of Materials, TU Graz, Graz, Austria

Since current Li-ion batteries suffer from limitations due to the chemical instability of their utilized organic electrolytes, a lot of research is focused on replacing them with more stable inorganic solid ion conductors. Cubic Li\textsubscript{7}La\textsubscript{3}Zr\textsubscript{2}O\textsubscript{12} (LLZO) garnets show high Li-ion conductivity as well as good electrochemical stability, making them very promising solid Li-ion conductors to be employed in future Li-ion batteries [1]. However, the application of LLZO could be hampered by its reactivity with water leading to Li+/H+ exchange in the crystal structure of the garnets [2, 3]. To investigate and understand this phenomenon, information about the exact H\textsuperscript{+} uptake is of uttermost interest.

In this work, we present a method for the spatially resolved determination of H in LLZO garnets using LIBS. Reliable signal quantification was obtained by preparing matrix-matched standards, carefully optimizing the measurement parameters (e.g. atmosphere, laser energy, gate delay) and applying appropriate signal normalization as well as background correction. Li+/H\textsuperscript{+} exchange caused by immersion in different media was investigated by conducting depth-profiling experiments on various LLZO samples, confirming significant H\textsuperscript{+} uptake during treatment with protic solvents.

References