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Exploring the limitations of garnet ceramic electrolytes for all-solid-state Li batteries

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The next generation of energy storage devices will rely on safe systems with increased energy density for stationary and mobility applications. An adequate combination of electrode materials with solid electrolyte in an all-solid-state battery could challenge the current technology. However, significant issues such as reliability and performances at high current rates still need to be overcome for practical application. Ceramic electrolytes such as Li-stuffed garnet materials are a good electrolyte candidates as they offer some of the highest Li-ion conductivities among solid electrolytes and good chemical compatibility with Li metal and oxide based electrode materials. We will report on the high Li-ion mobility of Ga-doped $Li_{7-\delta}La_3Zr_2O_{12}$ ceramic electrolyte, whose properties are strongly dependent on its synthesis route and processing. This material exists in two polymorphs: a tetragonal phase with low ionic conductivity (10-6 S/cm) but thermodynamically stable and a cubic phase presenting higher ionic mobility (10-4 S/cm). Partial substitution of Li+ by aliovalent dopants such Ga^{3+} forces the disordering of Li+ and ensures stabilization of the cubic phase. Additionally, a good control of the processing environment (ultra dry O_2) is crucial to obtain dense ceramics with the fastest conductivity reported so far (10^{-3} S/cm). The suitability of the developed Li-stuffed garnets as electrolytes for Li-ion batteries will be discussed. Battery applicability requires multi-component compatibility. Using a full device structure, the stability of the garnet electrolyte with Li metal electrode will be analysed and the limitations of the ceramics in an all-solid-state battery will be discussed.

Biography

Frédéric Aguesse received his PhD degree from Imperial College London in 2012, where he worked on functional ceramics and thin films. In February 2012, he started as a Post-doctoral Researcher, and then Associate Researcher (2015), at CIC EnergiGUNE (Spain) on ceramic materials for all-solid state batteries and post-mortem analysis of battery packs and full cell level. He works in developing all-solid state batteries and dedicates his skills for the development of ceramic materials with highly conductive Li-ions properties and their implementation in electrochemical devices.

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