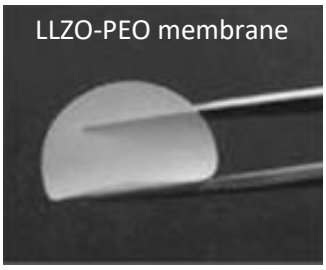
MASTER THESIS @ ic[TM]

Ceramics meet Polymers – Membranes for flexible solid-state Li-ion batteries



Ceramic-polymer composite electrolytes are emerging as a promising solution to deliver high ionic conductivity, optimal mechanical properties, and good safety for developing high-performance solid-state rechargeable batteries.

Ceramic electrolytes, such as $Li_7La_3Zr_2O_{12}$ LLZO, have a high Li-ion conductivity, a high lithium transference number approaching 1, and are electrochemical stable. They suffer, however, from brittleness and a high interface resistance to electrodes.

In contrast, solid polymer electrolytes have high flexibility and are lightweight, but show low ionic conductivities with low lithium transference rates (t_{Li} = 0.3 – 0.6), and poor electrochemical stabilities at high voltages.[1] Recently, attempts have been made to combine both materials, poly-ethylene-oxide (PEO) and LLZO in a composite electrolyte with the aim to profit from possible synergistic effects.[2]

Composite electrolytes are expected to show higher mechanical flexibility, lower interface resistance towards the electrodes compared to ceramic SE, and decreased instability of a rigid interface induced by the volume change of the electrode materials during cycling. Moreover, the rigid LLZO particles with PEO chain segments provide a mechanically robust and stable framework against the growth of dendrites. Additionally, the chemical and electrochemical performance of LLZO with Li metal allows the SE|Li interface to achieve a stable state.[3,4]

Despite all the promising advantages of composite electrolytes the unfavored ion transport across the PEO-LLZO interface leads to a high resistance limiting the development of, *e.g.*, flexible solid-state batteries.[5]

The aim of this master thesis is, therefore, the lowering of the interfacial resistance between LLZO and PEO using surface modifying techniques – recently developed at the ICTM. The successful candidate will use a wide variety of techniques to prepare and characterize composite membranes, using, *e.g.*, NMR, IR spectroscopy, impedance spectroscopy, cyclic voltammetry, and galvanostatic cycling.

Starting date: starting time as soon as possible, minimal duration 6 months

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References

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