Solid electrolytes for solid-state and lithium-sulfur batteries

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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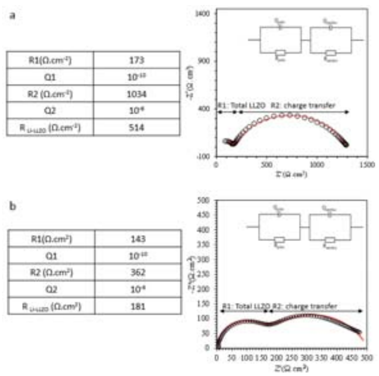
Technical Approach:

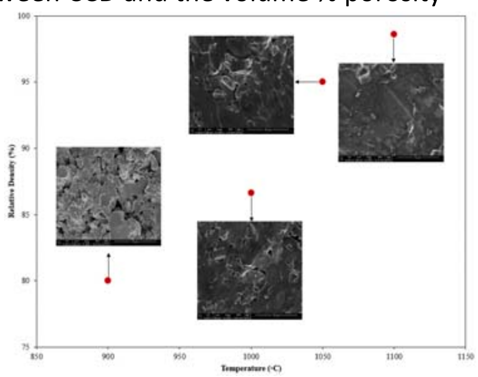
- Control atomic and microstructural defects in solid state electrolytes and correlate their concentration with the critical current density (CCD)
- Quantify the role(s) that each defect plays in controlling the CCD

Status:

- Correlated the effect of surface treatment with the CCD
- Using XPS, EIS, and computation analysis, it was determined that a surface treatment must be used to reduce the Li-LLZO interfacial resistance to increase the CCD
- The % porosity, was controlled by varying the densification temperature
- No obvious correlation was between CCD and the volume % porosity



EIS for cells using the standard (a) and the new (b) surface treatment



SEM images of LLZO fracture surfaces densified between 900 and 1100 C

Technology:

- Development and integration of solid ceramic oxide electrolyte membrane technology to enable the use of Li metal anodes and sulfur cathodes in batteries

Objectives:

- Enable advanced Li-ion solid-state and lithium-sulfur EV batteries using LLZO solid-electrolyte membrane technology.
- Demonstrate LLZO membranes can withstand current densities approaching ~1 mA/cm^2 (commensurate with EV battery charging and discharging rates).
- Demonstrate low area specific resistance (ASR) between Li and LLZO must be achieved to achieve cell impedance comparable to conventional Li-ion technology (~10 $Ohms/cm^2$).

Deliverables: Deliver LLZO membrane technology to enable Li metal anodes.

Funding:

Duration: 3 years

FY15 Budget: $416K (DOE)

Milestones:

- **Q3:** Experimentally evaluate critical current density based on surface contamination (LiOH, Li_2CO_3) and surface roughness
- **Q4:**Correlate the critical current density based on the pore size and volume fraction of porosity