Composite Electrolytes to Stabilize Metallic Lithium Anodes

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

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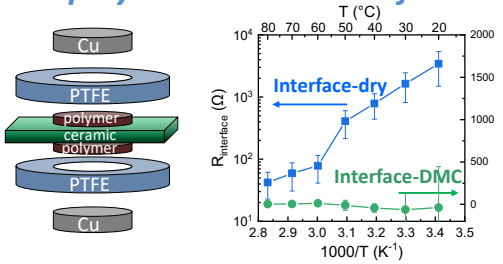
Objective:

- Prepare composite electrolytes to meet the challenging requirements to protect and stabilize the lithium metal anode;
- Understand the lithium ion transport at the interface between polymer and ceramic solid electrolytes.

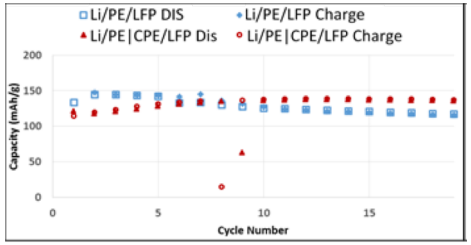
Impact:

- Design rules developed for this study will guide formation of composites with alternative and improved component phases as they become available.
- A thin, yet robust solid electrolyte membrane will enable use of metallic Li anodes for improved energy density.

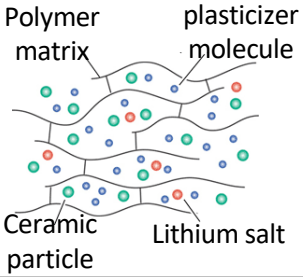
Facilitating ion transport across polymer-ceramic interface

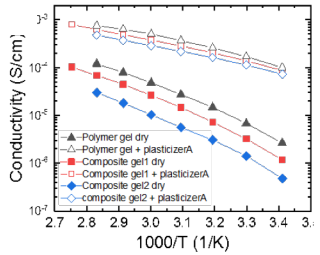


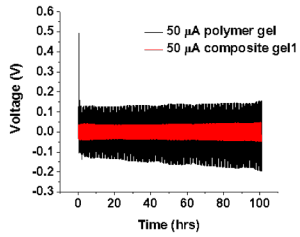
Performance of full cells with the composite electrolyte



Composite electrolyte with an alternative polymer gel







Accomplishments:

- The area specific resistance of the polymer-ceramic interface resistance is quantified to be 1600 Ω. We were able to decrease the interface resistance to zero within experimental error by adding DMC.
- When the composite electrolyte was coated with a thin polymer electrolyte to form the contact to the Li metal, the cathode $LiFePO_4$'s theoretical capacity was realized with good cycling stability over more than 20 cycles.
- A new composite electrolyte has been formulated with a promising room temperature conductivity of 10^{-4} S/cm. Preliminary results indicate good stability when cycling with Li contacts.

FY19 Milestones:

- Quantify thermal and mechanical properties of composite gel electrolyte.(Q1)
- Fabricate full cell with μm-scale Li film. Target discharge capacity: 120 mAh g^{-1} at 0.1 mA/cm^2 for 20 cycles. (Q2)
- Expand composite materials portfolio to include non-PEO type of polymer electrolytes. (Q3)
- Fabricate full cell with materials identified in Q3. (Q4)
- Collaborate with German team on Li-polymer interface. (Q4)

FY19 Deliverables: Demonstrate cycleability of full battery using non-PEO based composite electrolytes with thin Li anode.

Funding:

— FY19: $400,000 , FY18: $400,000 , FY17: $400,000