

High Conductivity and Flexible Hybrid Solid State Electrolyte

U.S. DEPARTMENT OF

ENERGY

Energy Efficiency &
Renewable Energy

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- **Objectives:**

- Develop flexible, high mechanical strength (~ 10 MPa) and thermally stable, hybrid solid state electrolytes.
- Achieve high room temperature ionic conductivity (≥ 0.5 mS/cm) and stable interface with Li metal that blocks dendrites at current densities up to 3 mA/cm^2 .
- Demonstrate Li-S battery performance of 450 Wh/kg and 1000 Wh/L , for 500 cycles.

- **Impact:**

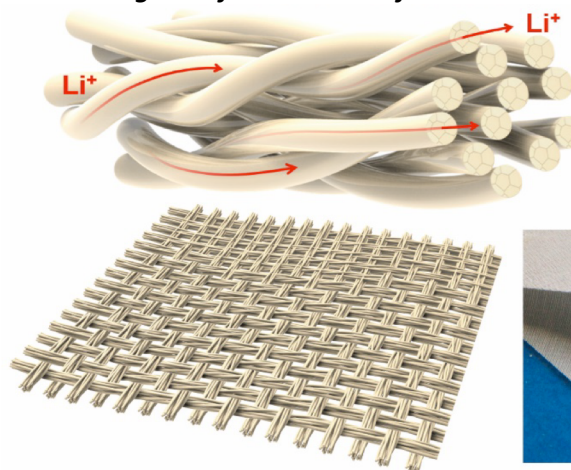
Success of this project will enable high-energy density, safe Li metal batteries with 2-3X energy density, that can be processed within the existing battery manufacturing infrastructure.

Accomplishments:

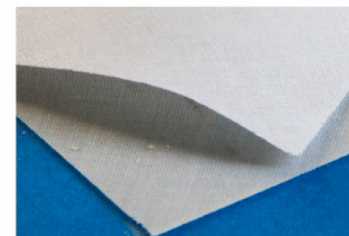
- Fully characterized electrochemical, mechanical and thermal properties of hybrid SSE.
- Fabricated hybrid SSE with a thickness of $\sim 20 \mu\text{m}$ and studied the Li-hybrid SSE interface through Li-SSE-Li symmetric cell cycling.
- Modeled ion diffusion, mechanical effects, and dendrite mechanisms in garnet nanofiber SSE
- Studied Li stripping and plating in thin SSE at a current density of $\sim 3 \text{ mA/cm}^2$ without shorting.
- Achieved Li metal cycling of hybrid SSE with no Li dendrite for 500 cycles at $\sim 3 \text{ mA/cm}^2$.

Hybrid Solid State Electrolyte

Flexible, solid-state, ion-conducting membrane with 3D garnet fiber networks for lithium batteries



- ◆ Flexible
- ◆ Lithium-ion conductive
- ◆ High surface/volume ratio
- ◆ Light weight
- ◆ Multi-scale porosity



FY 19 Milestones:

- Model Li dendrite protection to understand Li dendrite growth and protection effect of polymer and interphase layers on garnet nanofiber.
- Fabricate and evaluate porous framework of mixed electron and ion conductors to fill S cathode.
- Fabricate and evaluate Li-SSE-S full 1 cm by 1 cm cells.
- Achieve full cells with $\sim 10 \text{ mAh}$ and $\sim 450 \text{ Wh/kg}$ energy density.

FY19 Deliverables: Quarterly and annual reports

Funding:

— FY19: \$430,938, FY18: \$415,679, FY17: \$403,384