High conductivity, low temperature polymer electrolytes for lithium-ion batteries

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

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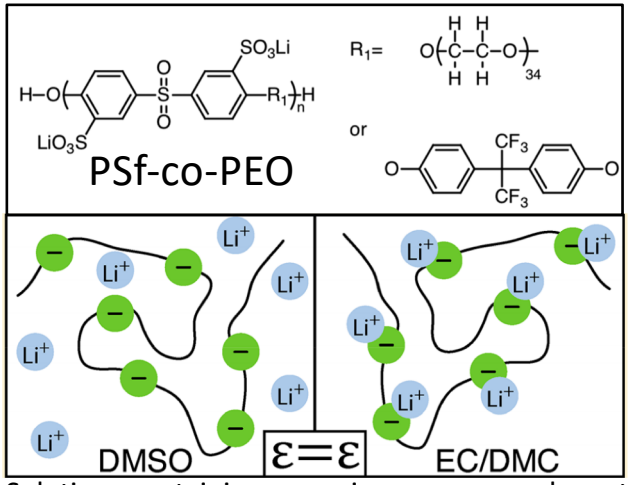
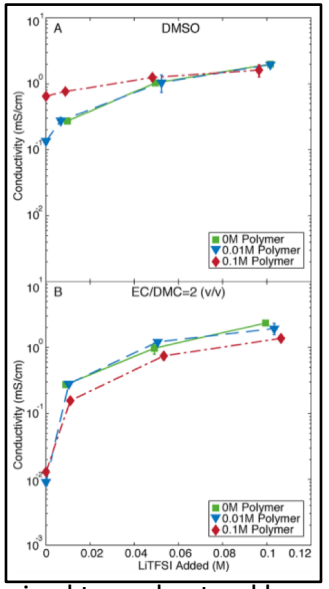
Objective: The overall project objective is to design an ionomer-based electrolyte that possesses a unique combination of high Li^+ transference number (>0.9) and liquid-like conductivities (>1 mS/cm) to enable faster charging Li-based batteries.

Impact:

- The high conductivity and Li^+ transference number targeted will improve battery energy density through the reduction of concentration gradients within the electrolyte in porous electrodes, allowing thicker electrode designs.
- These electrolyte properties also are theorized to improve Li metal plating and stripping uniformity by reducing current distributions across the electrode surface.

Compositional effects in polyelectrolyte properties





Solutions containing a new ionomer were characterized to understand how to achieve unique transport properties (Macromol., 2018, 51, 8761-71)

Accomplishments:

- Showed for the first time an anti-correlation between ionomer ion content and conductivity, known as the compensation effect.
- Showed that certain additives could be used to break the compensation effect and dramatically improve conductivity.
- Developed a 1D finite element battery model in COMSOL to identify target transference numbers and conductivities for electrolytes.
- Completed the first exhaustive study of nonaqueous polyelectrolyte solutions that use solvent and salt composition as variables. This study paves the way to appropriate polyelectrolyte design for LIB electrolytes.

FY19 Milestones:

- Complete synthesis and characterization of a new Li^+-neutralized charged polymer (pFTO). (Q1)
- Complete NMR transport and viscosity measurements of pFTO dissolved in carbonate-based solvents. (Q2)
- Complete electrochemical transport measurements of pFTO in symmetric cells. (Q3)
- Complete characterization of rate capabilities of battery cells with pFTO solutions. (Q4)

FY19 Deliverables: 2 publications, an optimized pFTO-in-carbonate solution with high transference number (>0.9) and conductivity greater than 1 mS/cm.

Funding:

— FY19: $250K, FY18: $250K, FY17: $250K