

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

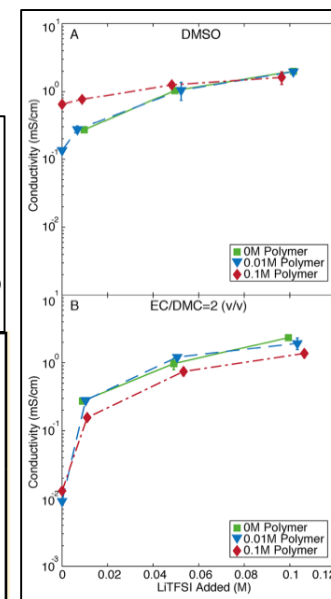
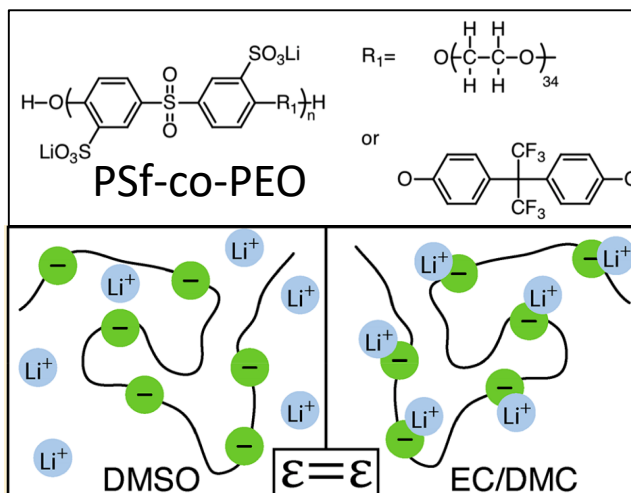
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**Objective:** The overall project objective is to design an ionomer-based electrolyte that possesses a unique combination of high  $\text{Li}^+$  transference number ( $>0.9$ ) and liquid-like conductivities ( $>1$  mS/cm) to enable faster charging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

## Impact:

- The high conductivity and  $\text{Li}^+$  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  $\text{Li}^+$ -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