Development of High-Energy Lithium-Sulfur Batteries

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**Objective:**
- Develop high energy lithium-sulfur (Li-S) batteries.
- Use advanced in situ techniques to understand reactions in Li-S batteries.
- Investigate the fundamental reaction mechanism of polysulfides.
- Improve the performance of high sulfur loading electrodes.

**Impact:**
- Li-S batteries have potentially 2-3 times higher energy than that of state-of-the-art Li-ion batteries and largely reduced cost. If successful, the proposed work will accelerate the market penetration of long-range electrical vehicles (EV), required by the EV Everywhere Grand Challenge proposed by DOE/EERE.

**Accomplishments:**
- Demonstrated 200 cycles for high loading sulfur electrodes (≥4 mg/cm²) with capacity retention over 80%.
- Identified electrolyte additive degradation mechanism at sulfur cathode side by in-situ/ex-situ techniques.
- Developed polymer coated membrane to minimize quick capacity drop and efficiency fluctuation during initial cycles of thick sulfur electrodes.
- Studied electrolyte/sulfur ratio on battery performance using large size pouch cells and high loading sulfur cathodes.

**Electrolyte degradation and its effects on high loading sulfur cathode**

- Identified degradation of electrolyte solvent, salt and additive on sulfur cathode, which affects sulfur utilization and cycle life particularly when using high loading sulfur cathodes and lean amount of electrolyte.

**FY 18 Milestones:**
- Study compatibility of electrolyte and binder with carbon host materials and their effects on sulfur utilization and cycle life.
- Design electrochemical cell using ceramic Li⁺ conductive separator for focused sulfur cathode study.
- Study failure mechanism of sulfur cathode under lean amount of electrolyte by removing the interference of Li anode.
- Develop functionalized separator to suppress polysulfide shuttle and improve interfacial stability of Li anode.

**FY 18 Deliverables:**
Large area double-side functionalized separator for high energy pouch cell assembly; quarterly/annual report.

**Funding:** FY18: $400K, FY17: $400K, FY16: $400K