Sulfur Cathodes for High Energy Li-S Batteries

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

PI/Co-PI Yi Cui (SLAC/Stanford)

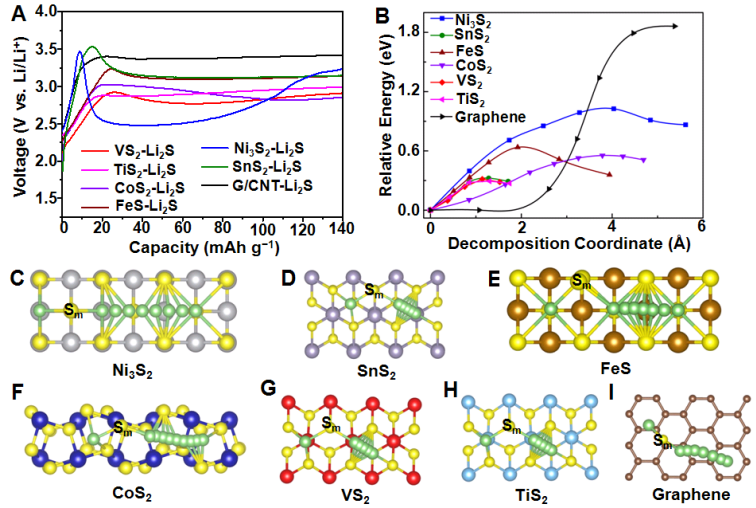
Objective:

Develop high capacity sulfur cathodes with long cycle life. Novel sulfur nanostructures as well as multifunctional coatings will be designed and fabricated to overcome the issues related to volume expansion, polysulfide dissolution and insulating nature of sulfur.

Impact:

- Sulfur cathodes for Li-S batteries have high specific energy for electric vehicles.
- Sulfur cathodes can offer potentially low-cost batteries to meet with the DOE cost target.

Electrochemical activation and Li_2S decomposition mechanism on the surface of various metal sulphides and graphene (PNAS, 2017, 114, 840-845)



Accomplishments:

- Identify the initial activation energy barrier of Li_2S on various metal sulphides
- Demonstrate the catalytic effect of Li_2Sx species on metal sulphides, enabling good performance of Li-S batteries
- Establish a standard procedure to quantitatively compare the polysulfide adsorption capability of candidate materials
- Quantitatively approximate the polysulfide adsorption amount of candidate materials

FY 18 Milestones:

- Increasing the mass and the percentage of sulphur loading in the electrode with high capacity loading (200 cycles with 80% capacity retention, >5mg/cm2 mass loading).
- Develop advanced aqueous inorganic polymer binder for high performance lithium-sulfur batteries with flame-retardant properties

FY18 Deliverables: Quarterly reports, battery cells meeting the desired deliverables

Funding:

— FY18: $300,000, FY17: $300,000, FY16: $300,000

OVERCOMING INTERFACIAL IMPEDANCE IN SOLID-STATE BATTERIES

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

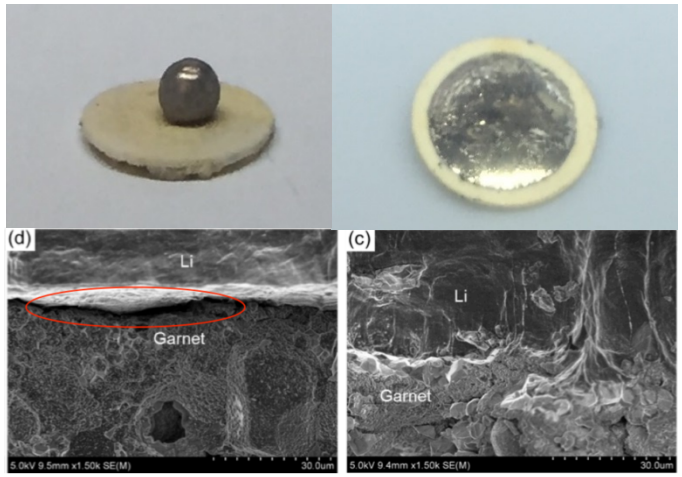
PI/Co-PI: Eric Wachsman (UMD)/ Liangbing Hu (UMD) / Yifei Mo (UMD)

Objective: Develop a multifaceted and integrated (experimental and computational) approach to reduce interfacial impedance of garnet-based solid-state Li ion batteries (SSLiBs).

Impact:

- Overcome primary issue with garnet electrolyte SSLiBs, interfacial impedance, thus enabling an entirely new safer (non-flammable) battery platform
- Enable highest capacity Li-metal anodes with no dendrites for higher energy density batteries (~500 Wh/kg)

Li Metal Wetting of Solid-State Electrolyte



Developed surface treatment to allow Li-metal wetting thus dramatically reducing interfacial impedance

Accomplishments: (FY16)

- First comprehensive investigation of interface impedance in garnet based SSLiBs
- Determined interfacial impedance as function of electrolyte/electrode contact area in 3D controlled solid state structures
- Developed computational models to investigate interfacial ion transport with interlayers
- Developed multiple efficient interlayer solutions to decrease interfacial impedance
- Demonstrated low interfacial impedance (~10 Ω cm^2) between both electrolyte and Li-metal anode and between electrolyte and cathode

FY 17 Milestones:

- Demonstrate full cells with NMC cathode
- Demonstrate full cells with Sulfur cathode
- Develop models to investigate interfacial transport for Li-S and Li-NMC SSLiBs
- Achieve full cell (Li-S or Li-NMC) performance of 350-450 Wh/kg and 200 cycles

FY17 Deliverables: Submission of 12 improved cells for government testing and evaluation

Funding:

— FY17: $401,634, FY16: $401,635 FY15: $409,608