Electrochemically Responsive Self-Formed Li-ion Conductors for High Performance Li Metal Anodes

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

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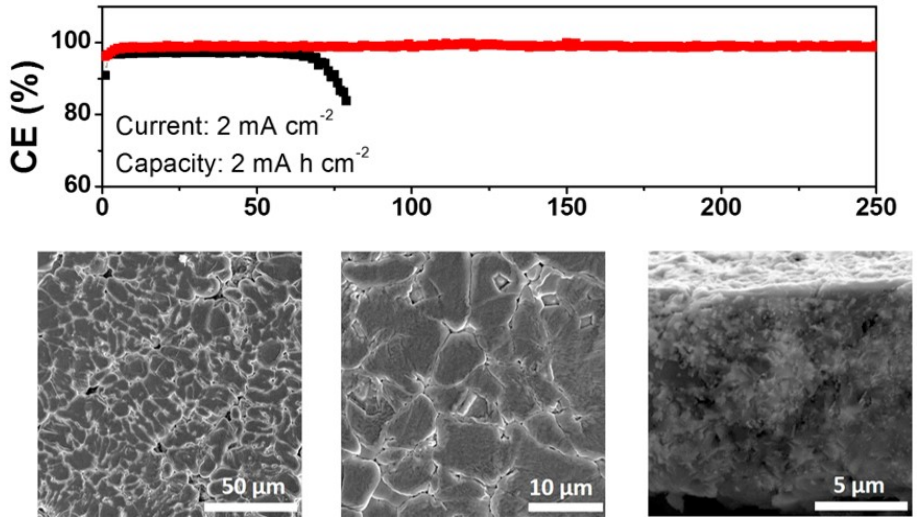
Objective:

Develop an electrochemically responsive self-formed hybrid Li-ion conductor as a protective layer which allow high Coulombic efficiency (CE) (> 99.7%) and long dendrite-free cycling. The Li-S pouch cells with high energy densities will be delivered using Li metal anodes with this protective layer.

Impact:

- Ion-conducting protective layers will stop lithium dendrite growth, prevent continuous SEI growth and enable the use of lithium metal anodes with high CE and long cycle life while avoiding hazardous shorting
- Ion-conducting protective layers will enable higher-energy-density, longer-cycling, safer Li-S batteries.

Li plating/stripping CE and morphology of deposited Li



Develop Li-ion protective layer to enable dendrite-free Li deposition and enhanced CE.

Accomplishments: (FY17)

- Develop 1st generation of organo-Li_xS_y lithium protection layers with tuned functionality.
- Determine the mechanical properties of organo-Li_xS_y lithium protection layers
- Demonstrate the uniform and dendritic Li deposition under the protection of organo-Li_xS_y lithium layers.
- Demonstrate an enhanced CE of ~99% CE over ~400 cycles at a rate of ~1 mA/cm^2 and deposition amount of ~2 mAh/cm^2.
- Fabrication a lithium-sulfur battery based on organo-Li_xS_y lithium protection layers with long cycling life (1000 cycles) and good capacity retention.

FY 18 Milestones:

- Develop 2nd generation of organo-Li_xS_y lithium protection layers with tuned functionality.
- Demonstrate the uniform and dendritic Li deposition under the protection of 2nd generation organo-Li_xS_y lithium layers.
- Demonstrate Li anodes using the Li-ion conducting layer with ~99.2% CE for ~300 cycles at a rate of ~1.5 mA/cm^2 and deposition amount of ~3 mAh/cm^2.

FY18 Deliverables: Demonstrate use of the protected Li anodes in Li-S battery cells.

Funding:

— FY17: $377,208; FY18: $379,773, FY19: $380,338