Lithium Dendrite Prevention for Lithium Batteries

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

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Objective:

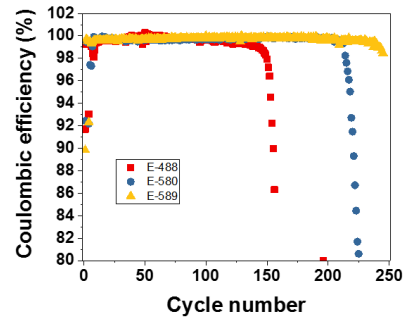
- To enable lithium (Li) metal as an effective anode in rechargeable Li-metal batteries for long cycle life at practical current density.

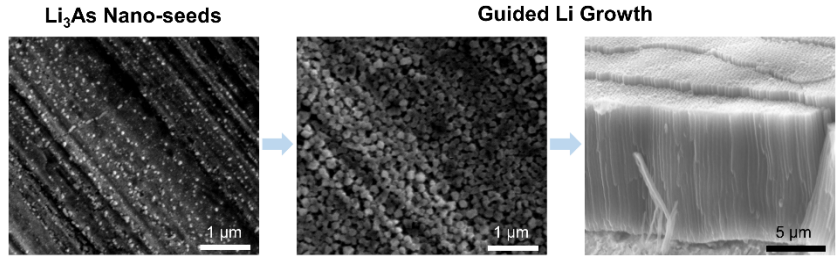
Impact:

- Understand the effects of various lithium salt mixtures, inorganic fillers and polymer types on ionic conductivity, Li CE, Li anode morphology, and battery performances in 4-V Li||NMC cells with relatively high areal loading.
- Develop new hybrid composite electrolytes that can lead to dendrite-free Li deposition with high CE will enhance Li metal anode and improve Li metal battery performances.

Significantly enhanced Li anode & cell performance

- (Right) Enhanced Li cycling efficiency and Li||NMC cycling stability by optimizing solvent compositions and adding combinational additives in LiTFSI-LiBOB/EC-EMC electrolytes.
- (Below) Revealed synergistic effects of additives $LiAsF_6$+VC in electrolyte on Li deposition morphology.





Accomplishments:

- Demonstrated that LiTFSI-LiBOB is the most stable dual-salt electrolyte among four imide-orthoborate dual-salts electrolytes on the stability of Li metal anode and the cyclability of related Li||NMC batteries.
- Identified the effects of Li capacity utilization (up to 4 mAh cm^{-2}) on the stability of Li metal anode and the cyclability of related Li||NMC batteries.
- Demonstrated the synergistic effects of additives $LiAsF_6$ and VC in electrolytes on Li deposition and the long-term cycling performance of Li||NMC333 cells.
- Increased average Li CE from 90.6% to 98.1% by optimizing the solvent compositions and adding combinational additives in LiTFSI-LiBOB/carbonate electrolytes.

FY 18 Milestones:

- Develop a lithium salt mixture with an ambient melting temperature and an ionic conductivity over 1 mS cm^{-1}
- Investigate effects of inorganic fillers and polymers on hybrid composite electrolytes
- Develop an inorganic/polymeric hybrid composite electrolyte with ionic conductivity over 1 mS cm^{-1} and Li CE over 99%
- Achieve over 300 cycles for 4-V Li||NMC batteries with ~ 2 mAh cm^{-2} cathode loading

FY18 Deliverables:

- Quarterly reports and annual report

Funding:

— FY18: $400K, FY17: $340K, FY16: $400K