Self-forming thin interphases and electrodes enabling 3-D structured high energy density batteries

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

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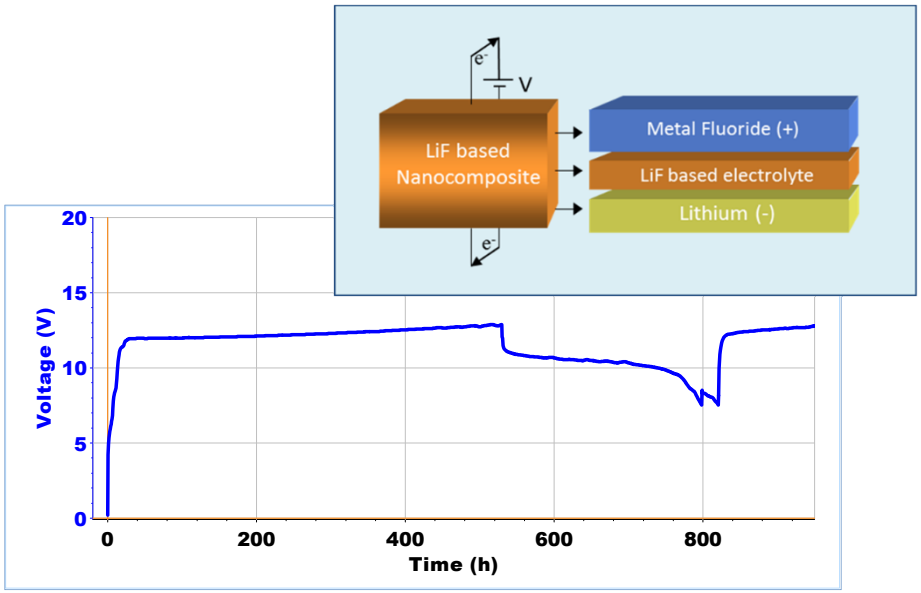
Objective: Develop and implement a novel in-situ formed lithium metal-based metal fluoride battery which will enable packaged 10 mAh batteries of energy densities > 1000 Wh/L and >400 Wh/kg at 12V within one planar unit.

Impact:

- Enable Li metal electrodes via solid state electrolytes
- Eliminate Li metal in fabrication and handling of cells
- Highest practical energy density electrochemical system
- Unique pathway to high voltage systems

In-situ formed lithium-metal fluoride battery



Accomplishments:

- Achieved self-formed cell-stack with > 580 Wh/L
- Achieved 12 V output in single unit cell of small dimension
- Implemented maskless scalable patterning technique for the fabrication of the self-forming cells
- Established positive reactive current collector compositions that achieved > 75% of the theoretical energy density
- Achieved > 95% utilization of Li at the negative during in-situ formation
- Established a bi-ion solid-state conducting glass compositions with ionic conductivity > $1x10^{-4}$ S/cm post formation

FY 19 Milestones:

- Design and fabrication of 10 mAh configuration cell stack that achieves 12 V and delivers 1400 Wh/L and 600 Wh/kg per cell stack (Q1)
- > 99% utilization of Li at the negative (Q2)
- < 30% electrolyte impedance increase after 50 cycles (Q3)
- > 90% utilization of positive electrode (Q4)

FY19 Deliverables: Deliver 12 baseline and 12 improved packaged-cells with 10mAh capacity. Improved cells with >1000 Wh/L and >400 Wh/kg, and output voltage of 12V.

Funding: *including 15.3% cost share*

- FY19: $ 399,903, FY18: $ 382,441, FY17: $ 488,821