

New Lamination and doping Concepts for Enhanced Li – S Battery Performance

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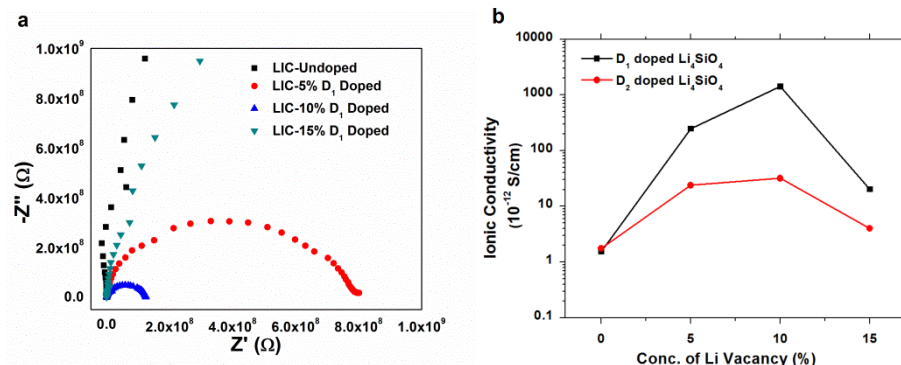
Technical Approach:

Phase – 1 (Year 1): Synthesis, Characterization and Scale up of suitable LIC matrix materials and multilayer composite sulfur cathodes. **Phase – 2 (Year 2):** Development of LIC coated sulfur nanoparticles, scale up of high capacity engineered LIC coated multilayer composite electrodes and doping strategies for improving the electronic conductivity of sulfur. **Phase-3 (Year 3):** Advanced high energy density, high rate, extremely cyclable cell development.

Status:

- Demonstration of effectiveness of LIC materials in improving sulfur cathode cyclability (4-5 mAh/cm²).
- Synthesis of high stability flexible sulfur nanowires (~0.003%fade/cycle) and complex framework materials (CFM) materials with stability over ~300 cycles.
- Development of polymeric LIC materials with doped oxide nanoparticles exhibiting stability over 100 cycles.
- Identification of doped inorganic LIC materials using first principles and synthesis thereof demonstrating ~3 orders of improvement in ionic conductivity.

Technology:



(a) Nyquist plot showing 3 orders drop in resistance of LIC materials by doping and
(b) Ionic conductivity vs. concentration of Li vacancies for various dopants.

Objectives:

To successfully demonstrate generation of novel approaches using lithium ion conductor (LIC) coatings and doping strategies to improve performance of sulfur cathodes for Li-S batteries to achieve the *EV everywhere* blueprint target.

Deliverables: Sulfur Cathode Targets: ≥350Wh/kg, ≥750Wh/l, high capacity ≥1400 mAh/g, cyclability (~1000 cycles), loss per cycle ≤0.01% per cycle, CE: ~80%. Cell Targets: 350 Wh/kg, 700 Wh/L, <\$150/kWh. Full cells meeting the desired deliverables (4 mAh).

Funding:

- Duration - 3 yrs
- Total - \$1,250,061.00
- DOE - \$1,250,061.00
- Industry - \$0.00

Milestones:

- Q1 Milestone: Synthesis of doped LIC particles, testing thereof.
- Q2 Milestone: Development of LIC coated sulfur nanoparticles.
- Q3 Milestone: Develop interface engineered cathode materials with VACNT-sulfur-LIC material. Synthesis of interface engineered materials with superior rate capability, improved capacity, improved cycling stability (≤0.05% per cycle).
- Q4 Milestone: Develop LIC coated sulfur nanoparticles for use as bulk cathode materials by interface/surface coating with Li ion conducting materials; Synthesize LIC coated sulfur nanoparticles exhibiting: Specific capacity ~1000 mAh/g, cyclability (~1000 cycles), loss per cycle ≤0.05% per cycle.