Development of Si-based High Capacity Anodes

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

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Technical Approach:

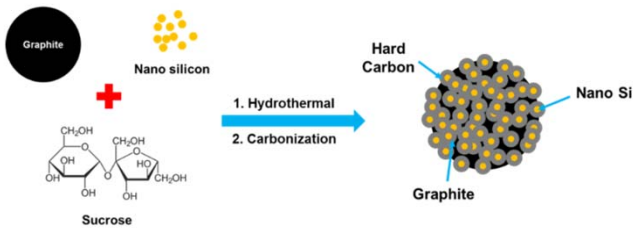
- Use hydro thermal assistant methods to prepare hard carbon coated nano-Si/graphite composite and alleviate the volume expansion of silicon during charge/discharge process.
- Use *in situ* chemical reduction methods to prepare Nanocomposites of Si and amorphous or crystalline lithium oxide (Si+Li_2O)

Status:

- Developed Si-based nanocomposites with a capacity of ~878 mAh/g and > 80% capacity retention over 150 cycles for thick electrodes (~2 mAh/cm^2).
- Synthesized Si nanoflakes with a stable capacity of ~780 mAh/g at high cycling rates of 2A/g.

Technology:

- Hydrothermal method can be tailored to control the structure and void in Si anode and minimize the side reaction between Si and electrolyte.
- The chemical reduction method can lead to stable Si structure with *in situ* formed void space.



Objectives:

- Develop high-capacity, low-cost Si-based anodes with good cycle stability and rate capability to replace graphite in Li-ion batteries.
- Prepare nanocomposites of silicon and Li-ion conducting lithium oxide by *in situ* chemical reduction methods. The electrode structures will be modified to enable high utilization of thick electrode.

Deliverables: >80% capacity retention over 300 cycles for thick electrodes (> 2 mAh/m^2)

Funding:

FY16 Budget: $540k (DOE)

Milestones:

- Q1: Synthesize Si-based nanocomposite of ~800 mAh/g.
- Q2: Achieve 80% capacity retention over 200 cycles for hard carbon coated nano-Si/graphite composite anodes.
- Q3: Optimize solid state synthesis techniques for generation of active-inactive composite with capacities ~1000-1200 mAh/g.
- Q4: Achieve >80% capacity retention over 300 cycles for thick electrodes (> 2 mAh/m^2) through optimization of the Si electrode structure and binder.