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

Overview and Progress of the Exploratory Technology Research Activity: Batteries for Advanced Transportation Technologies (BATT)

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Tuesday, May 10, 2011

Project ID: **ES108**

Overview

Perform cutting-edge research on new materials, and address fundamental chemical and mechanical instabilities.

Timeline

- Start – October 2008
- Finish – September 2014
- 33% Complete

Budget

- $15.1 million in FY 2010
- $22.3 million in FY 2011

Challenges

- Research and develop next generation anode and cathode materials
- Understand failure mechanisms to enable higher energy, longer lasting, less expensive batteries
- Comprehensive modeling of cell and material behavior

Participants

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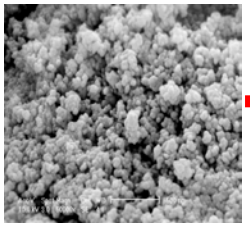
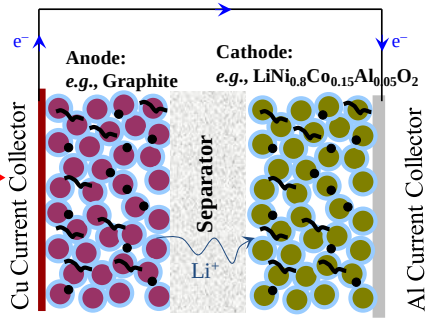
Material Synthesis, Diagnostics, and Modeling Across Length Scales

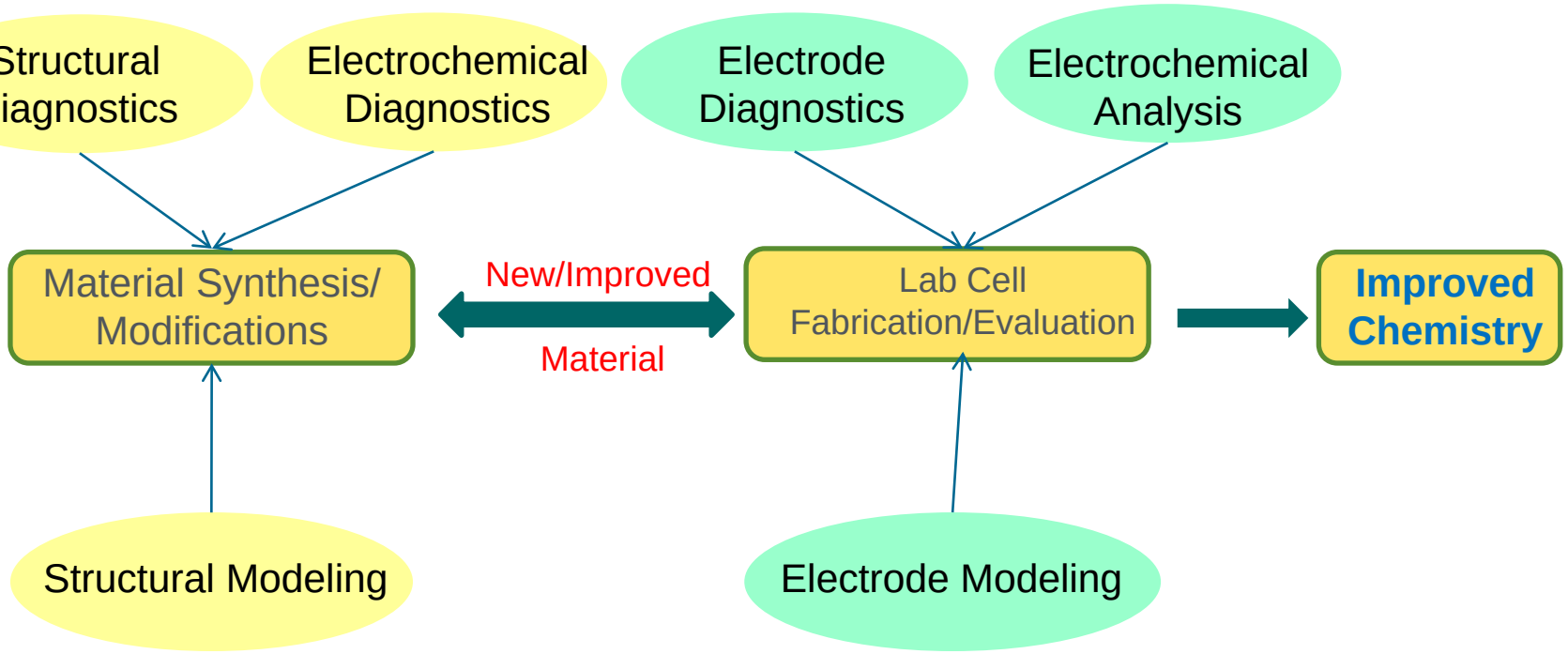


10 nm-10 μm

Length Scales



100μm-300μm



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The BATT Portfolio in 2011

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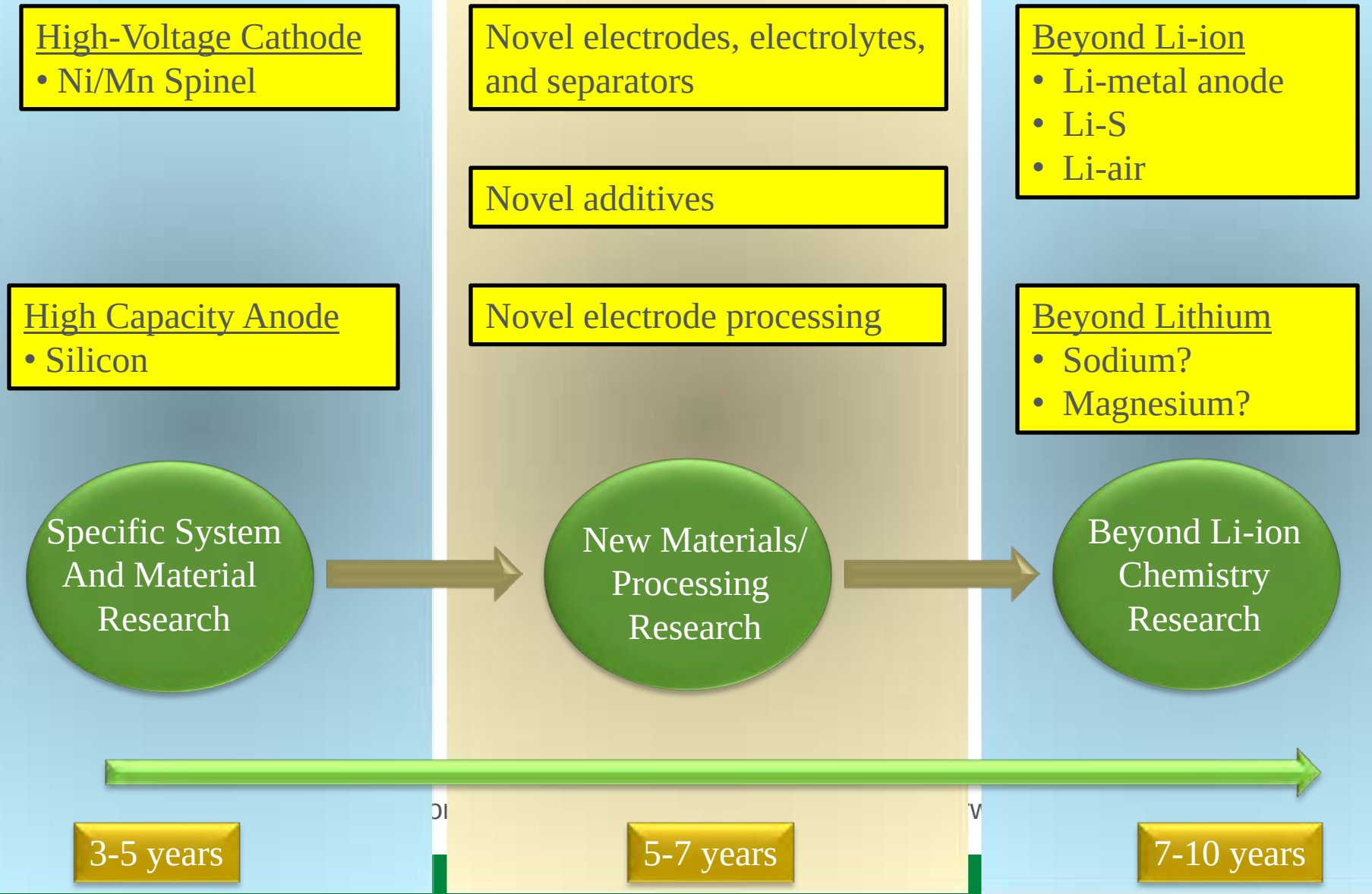
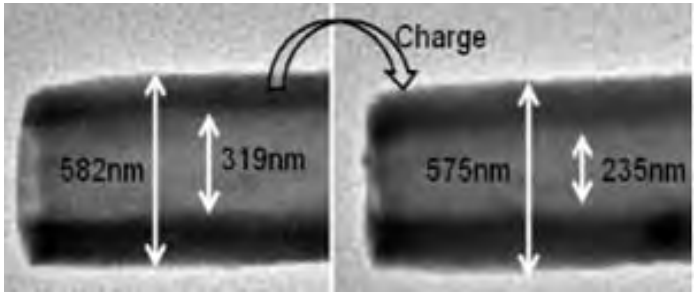
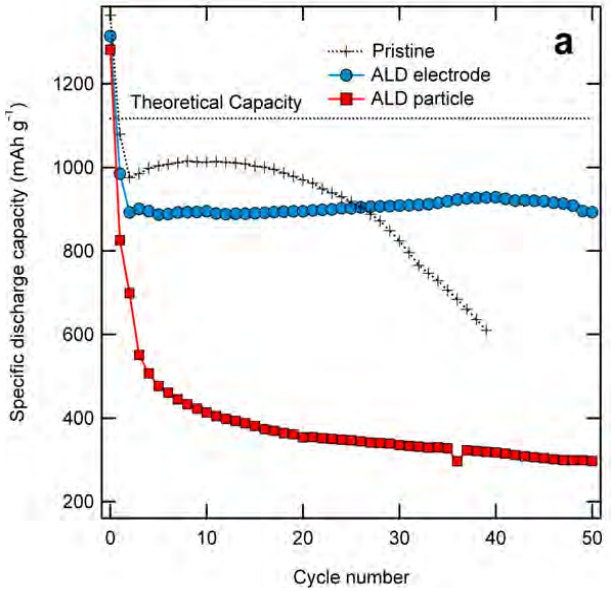


2010 Anode Highlights

- Cui's group at Stanford demonstrated that size & morphology control can improve performance: hollow Si nanotubes show greatly enhanced cycling.



- Dillon's group at NREL applied "atomic layer deposition" coatings to MoO_3 nanoparticle-based anodes. ALD-coated particles do not cycle nearly as well as ALD-coated electrodes.



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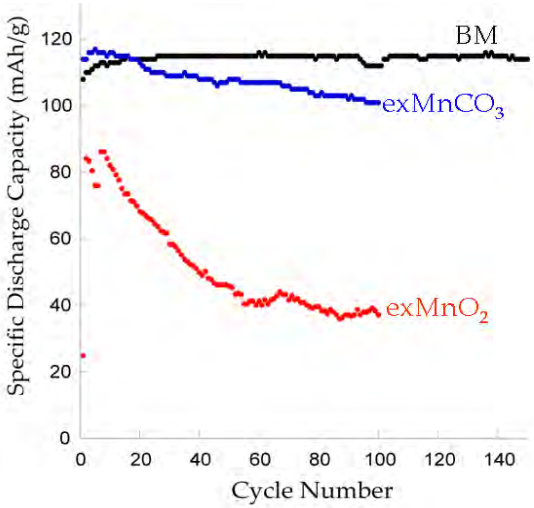
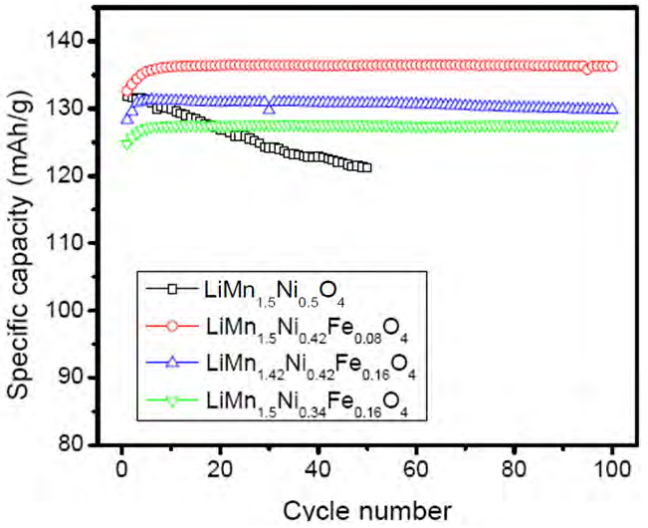
2010 Cathode Highlights

- Cabana's group at LBNL compared the cycling ability of high-voltage $LiNi_{1/2}Mn_{3/2}O_4$ with different sizes and morphologies. Nanostructures (blue and red) may not improve performance.



- Manthiram's group at University of Texas produced an Fe-doped, high-voltage material that cycles well at 4.8 V and 137 mAh/g.



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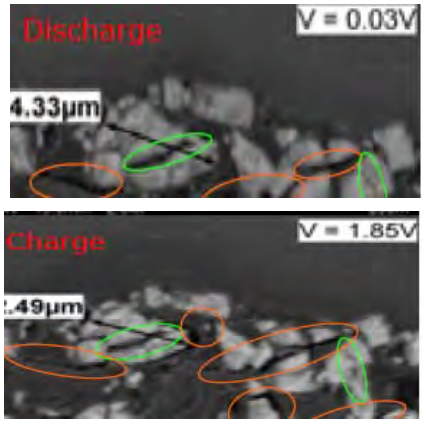
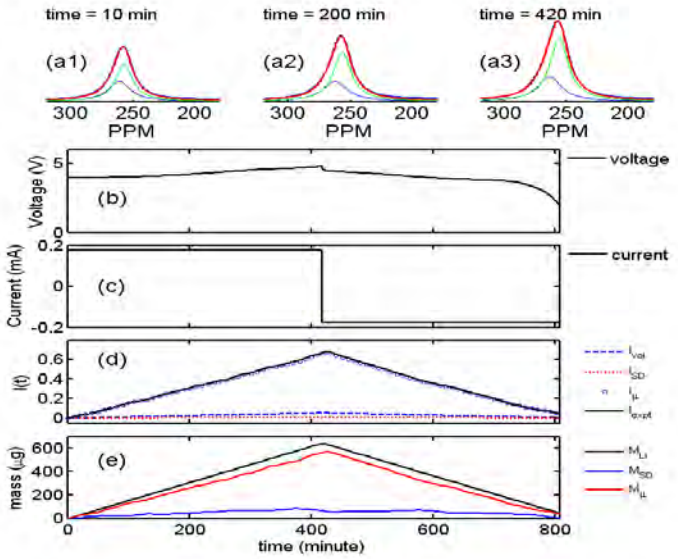
2010 Diagnostics Highlights

- Zaghib's group at Hydro-Quebec developed an *in situ* SEM tool to directly observe the expansion/contraction of silicon oxide anodes. Cracks formed during expansion remain after contraction.



- Grey's group at Stony Brook Univ. developed an *in situ* NMR technique to differentiate between bulk and dendritic Li, monitor the growth of µm-sized dendritic/mossy Li, and determine what Li participates in the electrochemistry.



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All Projects are Competitively Selected

- Request for Proposals Schedule:
  - 2008 – New electrolytes
  - 2009 – New anodes
  - 2010 – New cathodes

  - Nov. 2011 – Advanced Diagnostics, Modeling and Assembly of Battery Materials and Electrodes
  - Nov. 2012 – Novel Electrolytes and Additives
  - Nov. 2013 – Novel Anode Materials and Structures
  - Nov. 2014 – Novel Cathode Materials and Structures

New Electrolyte Projects

Investigator	Institution	Project
K. Amine	ANL	Advanced Electrolytes and Electrolyte Additives
C.A. Angell	Arizona State	Sulfones with Additives as Electrolytes
W. Henderson	North Carolina State	Inexpensive, Nonfluorinated (or Partially-Fluorinated) Anions for Lithium Salts and Ionic Liquids
B. Lucht	U. of Rhode Island	Development of Electrolytes for Lithium-ion Batteries
D. Scherson and J. Protasiewicz	Case Western Reserve	Bifunctional Electrolytes for Lithium-ion Batteries

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New Anode Projects

Investigator	Institution	Project
K. Chan	Southwest Research Institute	Synthesis and Characterization of Si Clathrates for Anode Applications in Li-ion Batteries
Y. Cui	Stanford	Wiring Up Silicon Nanoparticles for High-Performance Lithium-ion Battery Anodes
A. Dillon	NREL	ALD for Stabilization of Amorphous Silicon Anodes
Y. Gogotsi	Drexel	New Layered Nanolaminates for Use in Lithium Battery Anodes
P. Kumta	U. of Pittsburgh	Nanoscale Heterostructures and Thermoplastic Resin Binders: Novel Li-ion Anode Systems
M. Thackeray	ANL	Three-Dimensional Anode Architectures and Materials
S. Whittingham	Binghamton U.	Metal-Based High-Capacity Li-ion Anodes
D. Wang	Penn State	Synthesis and Characterization of Polymer-Coated Layered SiO_x-Graphene Nanocomposite Anodes

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New Cathode Projects

- 102 white papers received
- Initial review completed
- Full proposals requested
- Selections expected summer 2011

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2011 Plans

- New focus groups to understand critical issues with high-voltage spinel cathodes and Si anodes
  - $LiMn_{1.5}Ni_{0.5}O_4$ system: side reactions and transport properties. Will continue to understand and improve this system and the electrolytes to be used with it.
  - Si anode: define a baseline for new binder studies, investigate shape and morphology impacts on cycling, and new surface coatings and additives to stabilize the anode.
- Complete evaluation of new cathode project proposals and award new contracts
- Solicit new proposals for advanced diagnostics, modeling and assembly of battery materials and electrodes

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