BATT Program- Summary and Future Plans

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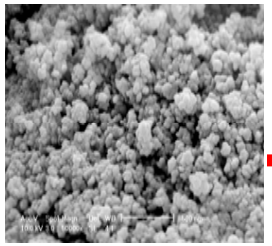
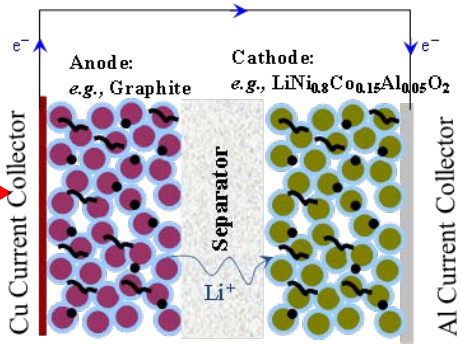
Material Synthesis, Diagnostics, and Modeling Across Length Scales



10 nm-10 μm

Length Scales



100 μm-300μm

Structural Diagnostics

Electrochemical Diagnostics

Electrode Diagnostics

Electrochemical Analysis

Material Synthesis/ Modifications

New/Improved Material

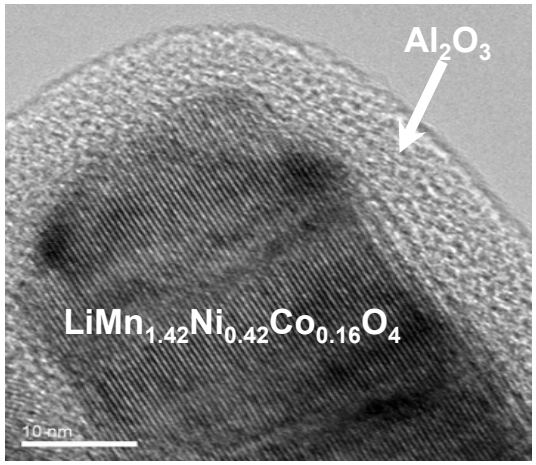
Electrode/Battery Fabrication

Improved Chemistry

Structural Modeling

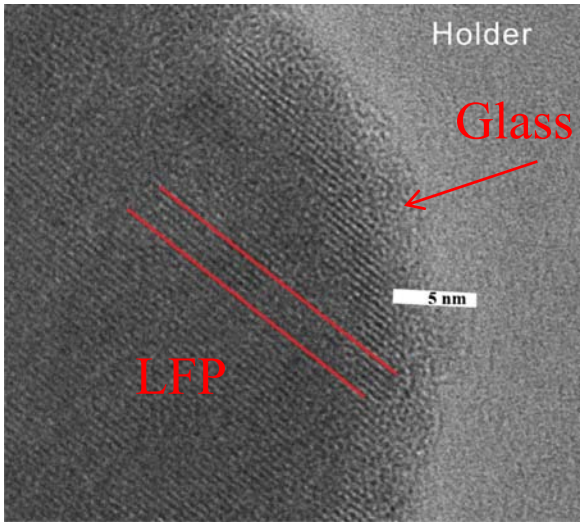
Electrode Modeling

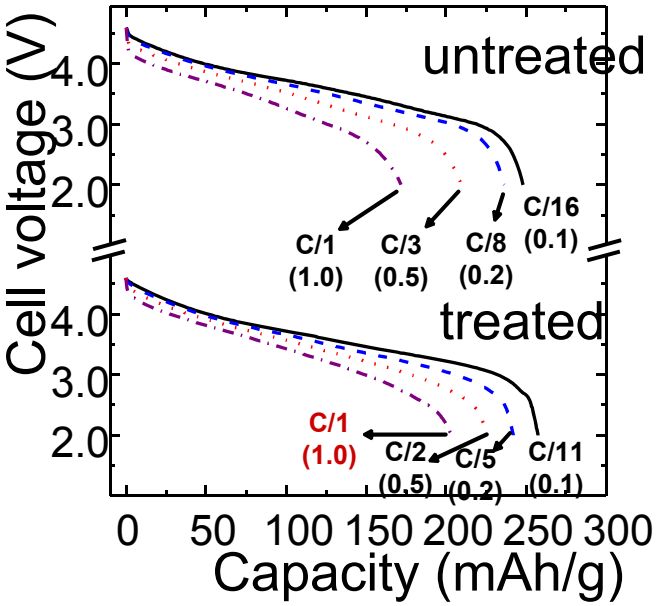
Highlights of BATT in FY09-Coatings Enhance Performance



- Surface modification dramatically improves the rate capability of 5 V spinels by suppressing the growth of the a SEI layer (Manthiram)

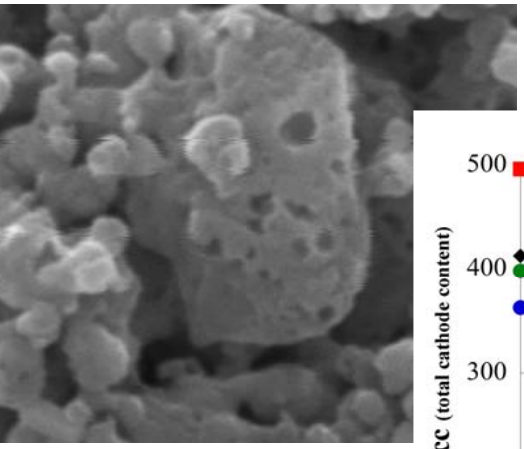
- Surface treatment of $LiFePO_4$ cathodes improves rate performance (Ceder)

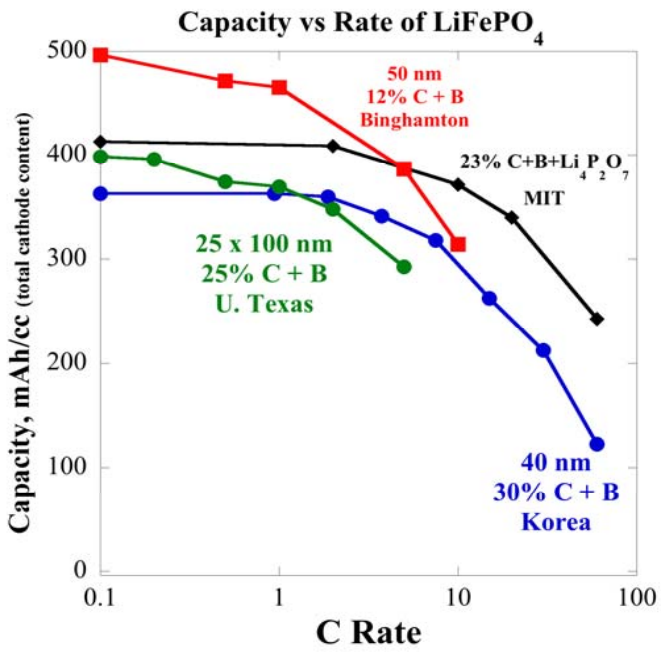




- Li-Ni-PO_4 protects the surface of $xLi_2MnO_3 \bullet (1-x)LiMO_2$ electrodes (M=Mn, Ni, Co) at high potentials (Thackeray)

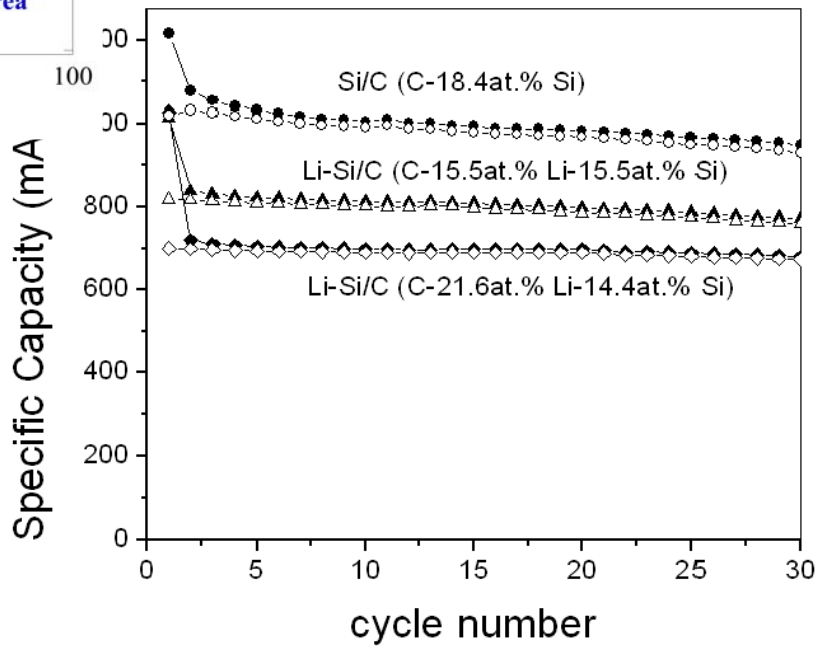
Highlights of BATT in FY09-NanoStructures Enhance Performance



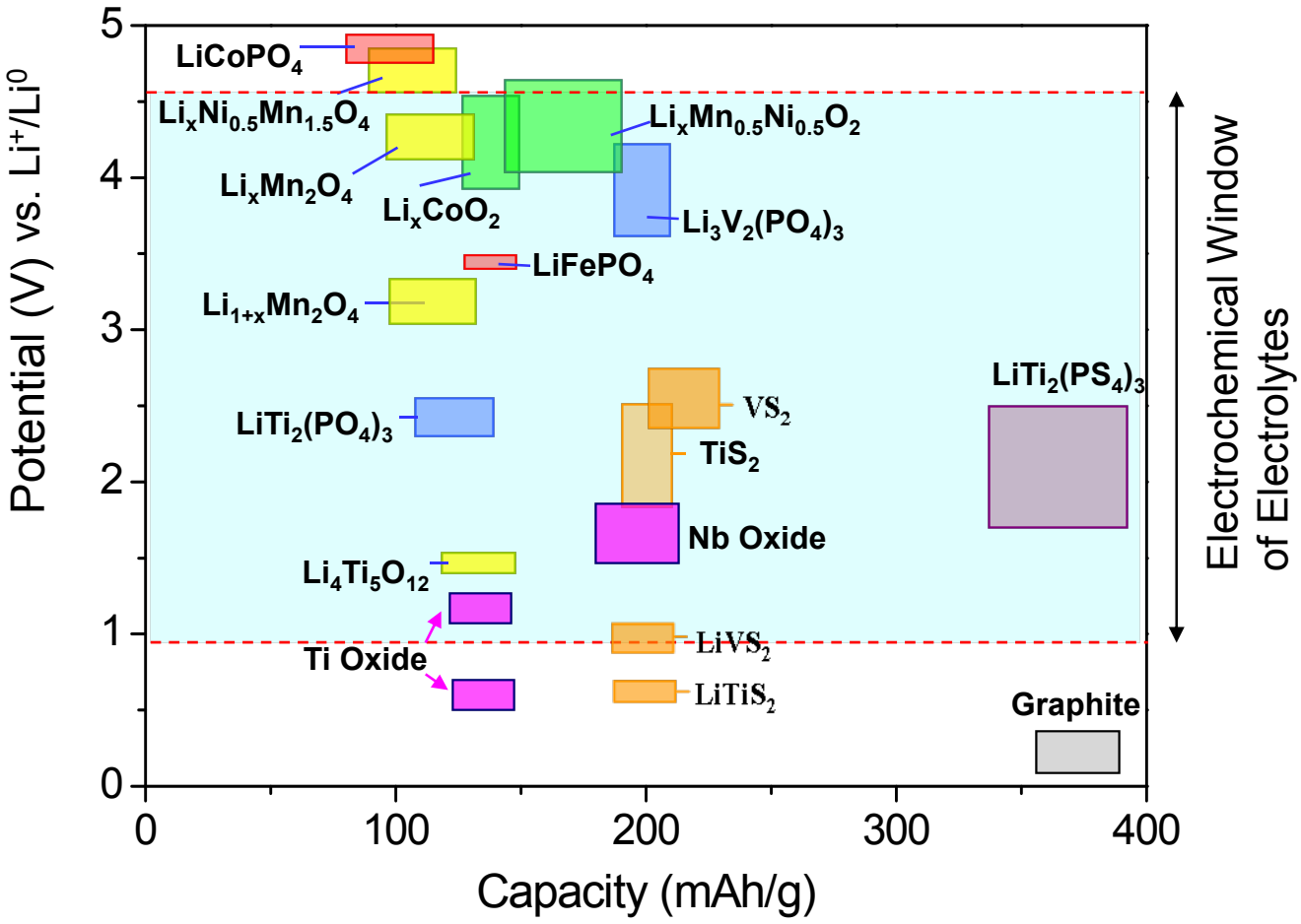


• Nanostructures of 50 nm crystallite in 1-3 μm particles allow a low carbon+binder content (Whittingham)

• Si/C nanocomposites show excellent cycleability with high capacities and low 1st cycle loss (Kumta)

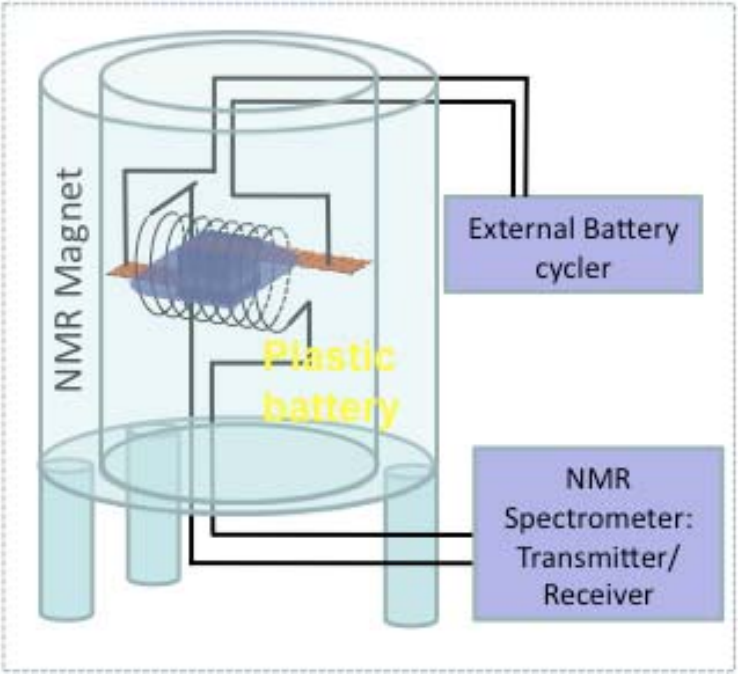


Highlights of BATT in FY09-Discovering New Materials



- Numerous alternative anode materials have been synthesized (Goodenough)
  - Capacities larger than $Li_4Ti_5O_{12}$ but at potentials that prevent SEI formation
  - Provides hope for high energy, long life batteries for PHEVs

Highlights of BATT in FY09-Diagnostics Technique Enhance Understanding



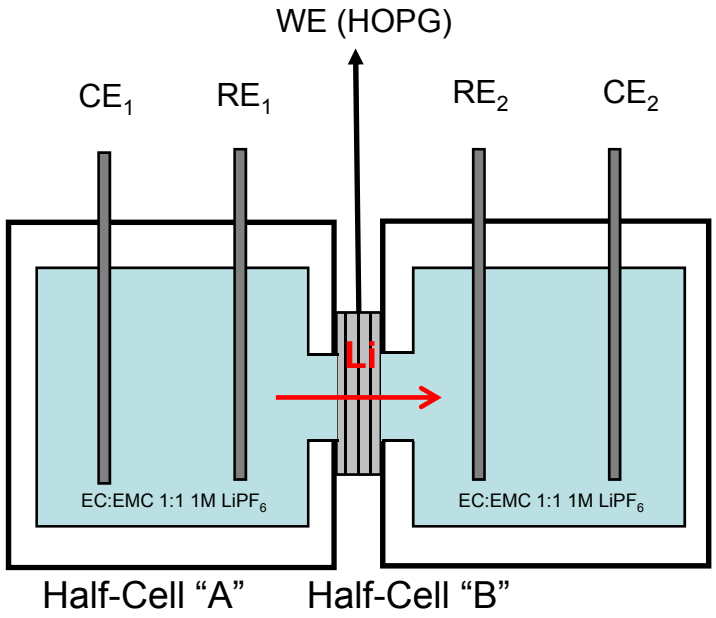
NMR spectrometer working in synchrony with the battery cycler.

- The *in situ* NMR studies on silicon anodes showed presence of highly reactive meta-stable phases that reducing the electrolyte (Grey)

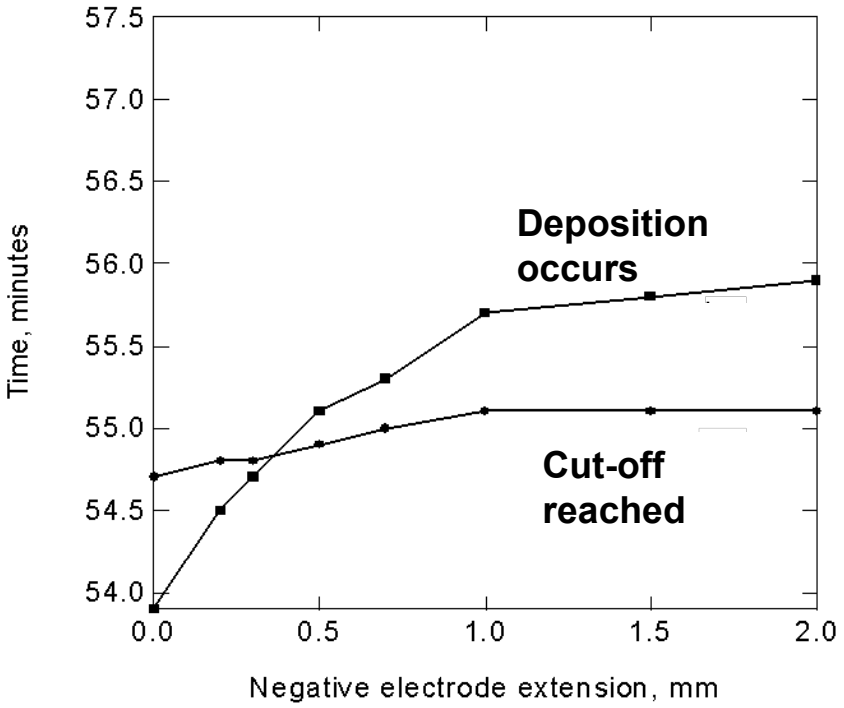
- Process could be slowed down significantly in the present of a coating or binder such as carboxoymethylcellulose.

- Two different mechanisms of Li diffusion in graphite were revealed and quantified (Kostecki)

- Li diffusion in between graphene planes is much faster that along the grain boundaries



Highlights of BATT in FY09-Modeling across Length Scales

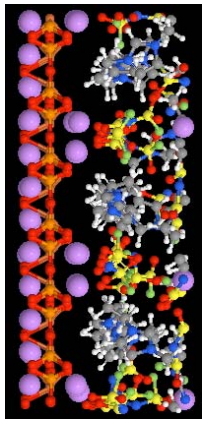


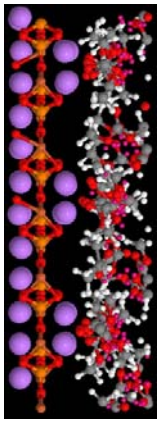
- Continuum models allow identification of conditions under which Li plating can occur in cells with mismatched electrodes (Newman)

- Results show that a 0.5 mm extension of the anode enough to prevent Li plating within the time to reach the cutoff potential

- Simulations of $LiFePO_4$/electrolyte interface show substantial interface-induced structure in the electrolytes (Smith/Borodin)

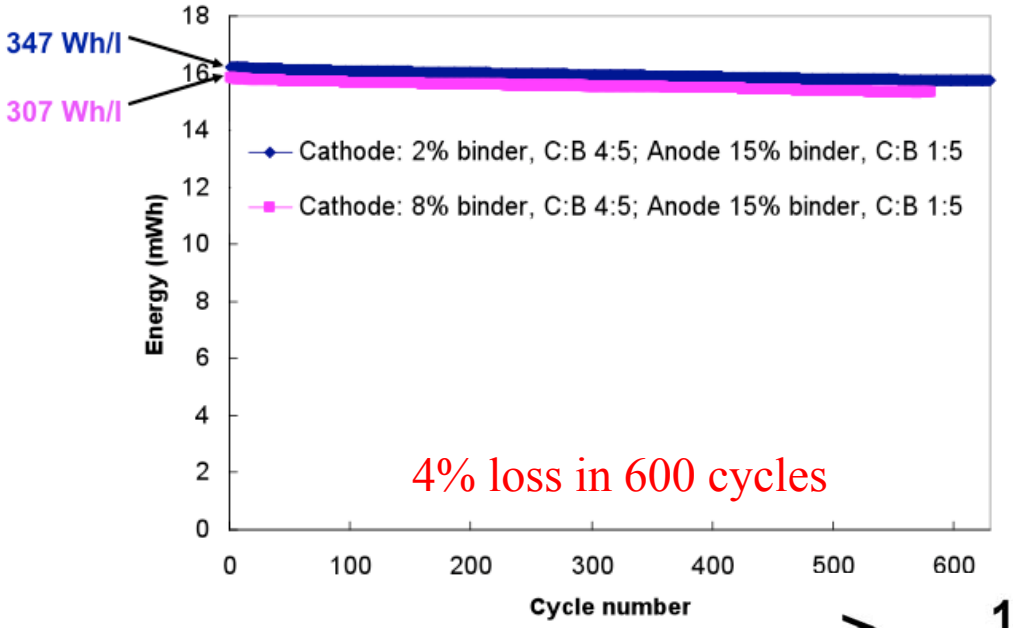
- A large barrier to transport of Li^+ to the surface is seen as evidenced by low Li+ concentration near the interface





EMIM/FSI + LiFSI EC/DMC + $LiPF_6$

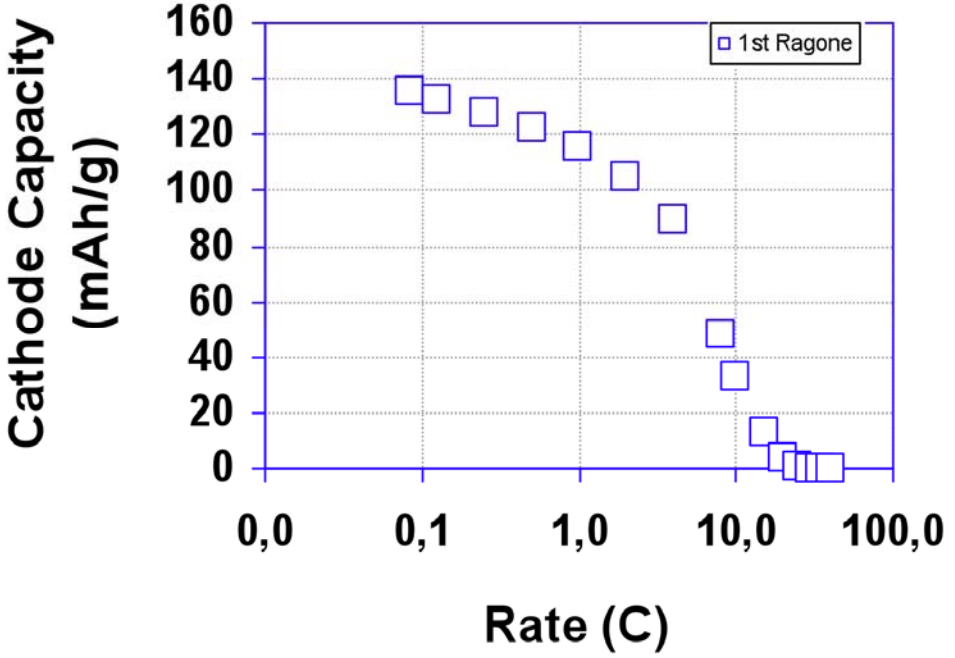
Highlights of BATT in FY09-Cell Analysis



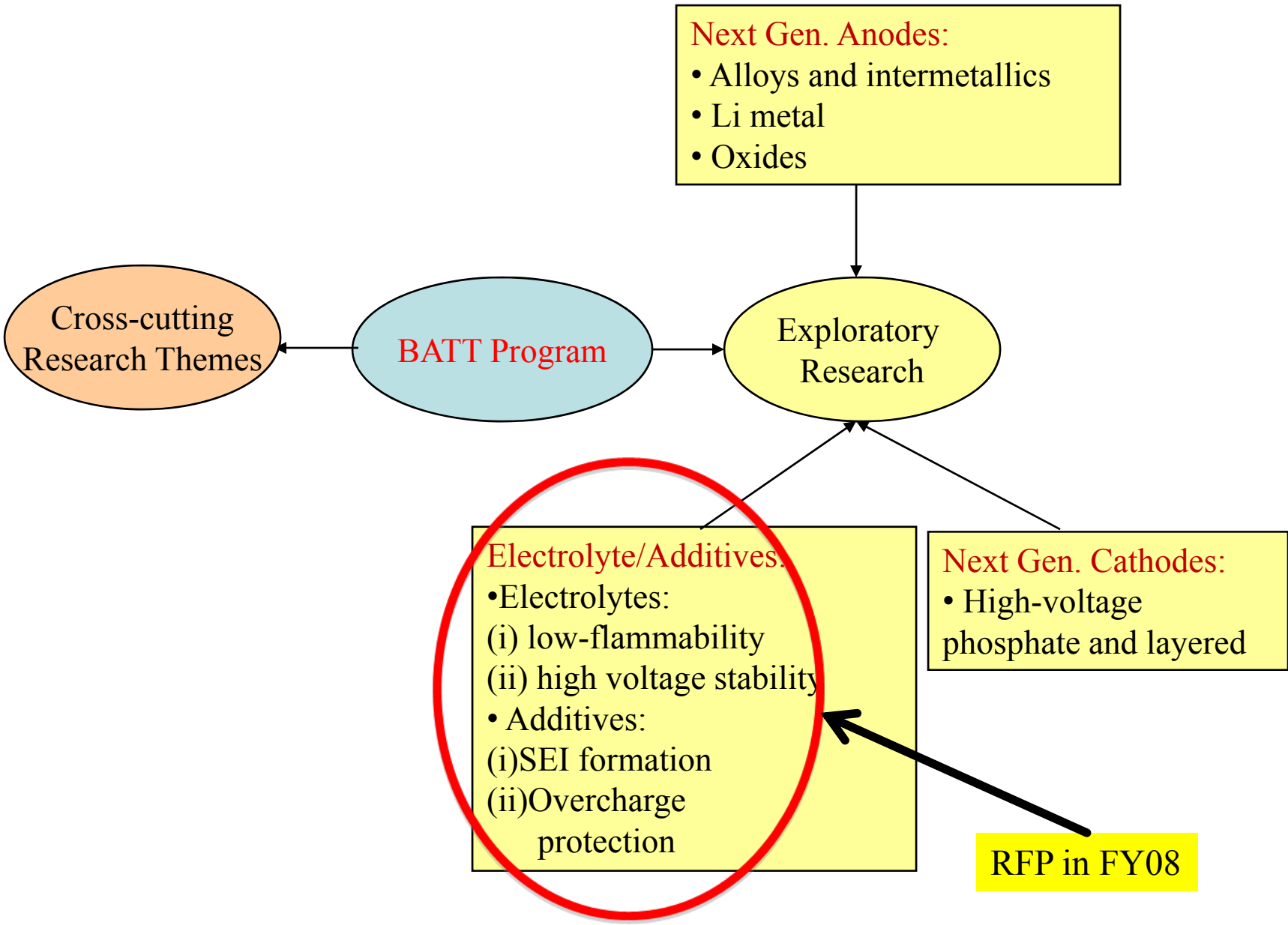
- Optimized cathodes and anodes show excellent performance under PHEV cycling conditions (Battaglia/Liu)

- Blended cathodes take advantage of rate/capacity of one material while enhancing overcharge protection characteristics (Zaghib)

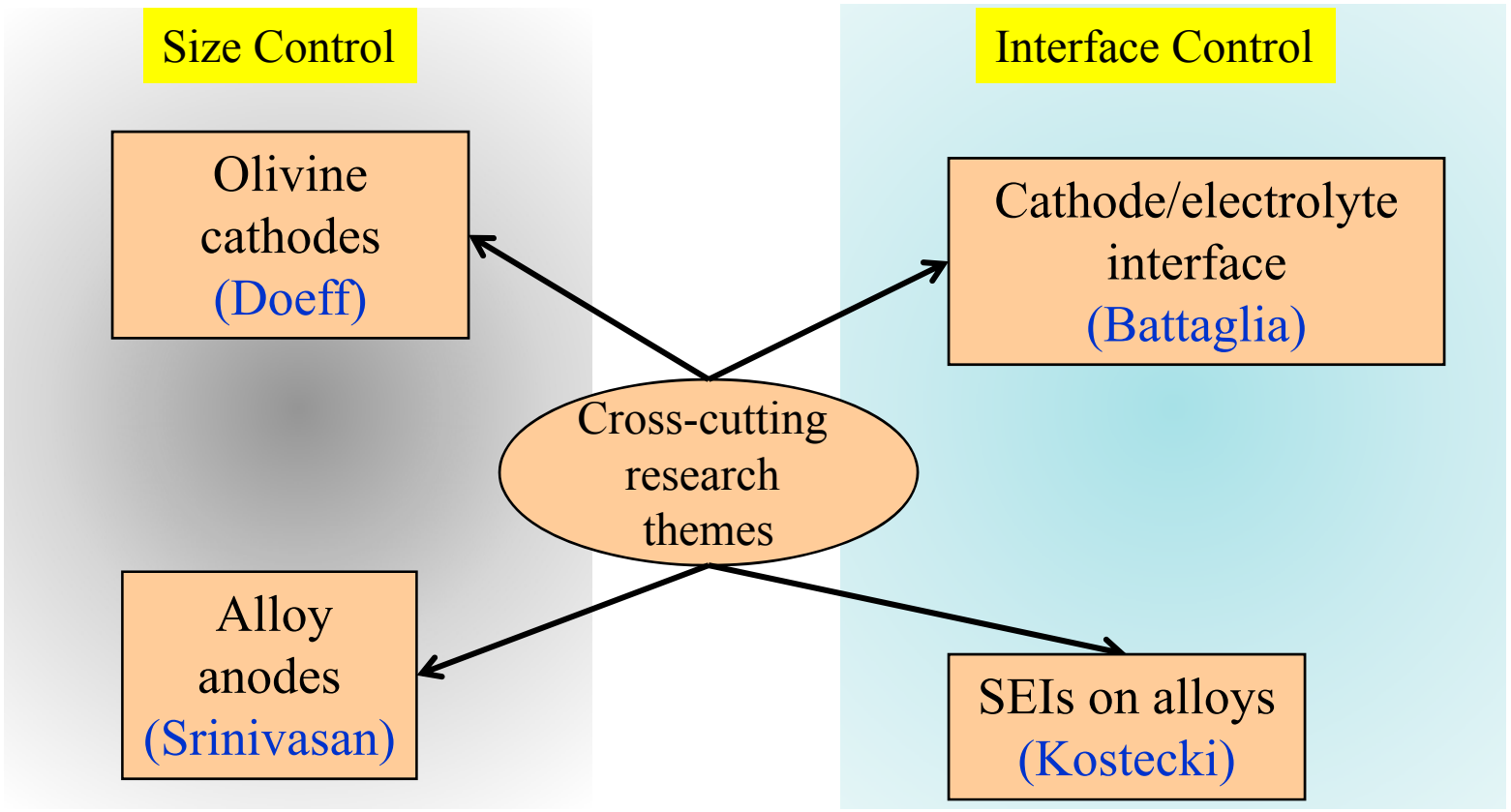
$LiMnPO_4$/NMC Blended cathode



Emphasis of the BATT Program- FY09



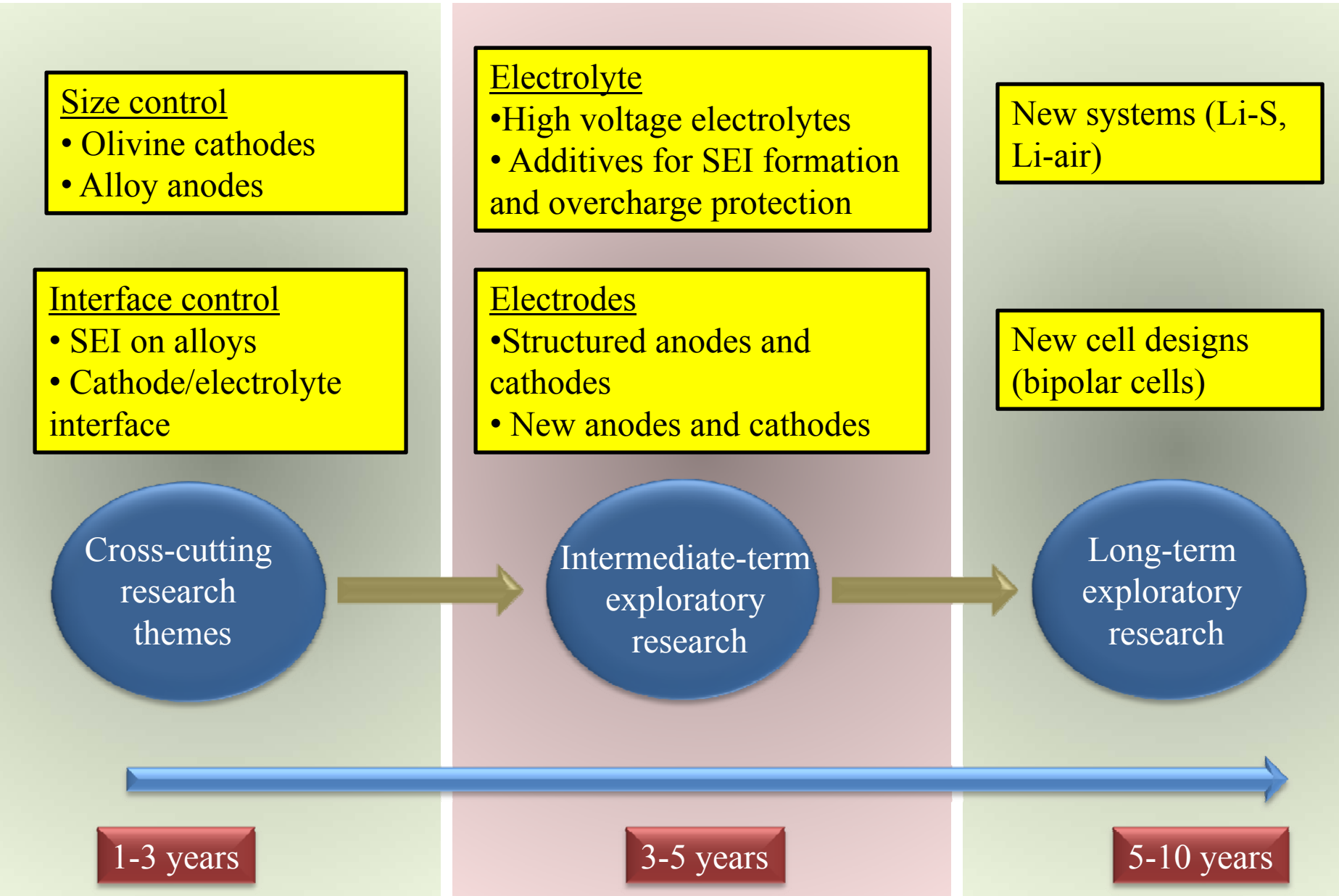
Focus Areas for FY09



- One PI has been asked to lead each area. PI is coordinating the research activities.

If successful, these topics will result in the development of a high-energy battery with enhanced safety and long life.

Structure of BATT in FY09-10



Acknowledgements

- BATT Program participants
  - Especially Frank McLarnon, Vince Battaglia, John Newman, and Susan Lauer

- DOE Office of Vehicle Technologies

For additional information see http://batt.lbl.gov