Interfacial Processes – Diagnostics

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

PI: Robert Kostecki (LBNL)

Technical Approach:

- Apply *in situ* and *ex situ* advanced spectroscopy and imaging probes to characterize physico-chemical phenomena on electrochemical interfaces and Interphases in composite electrodes and battery cells
  - Design and employ new experimental methodologies to study Li-ion materials and cell components
  - Use model single crystal/particle electrodes to determine the mechanism and kinetics of detrimental processes

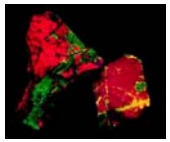
Status:

Pioneered the use of near-field FTIR spectroscopy and imaging for direct chemical analysis of SEI layer. Determined the mechanism of transition metal dissolution in LMNO and LMNC electrodes.

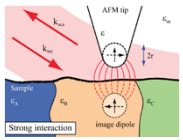
Technology:

Li-ion cell

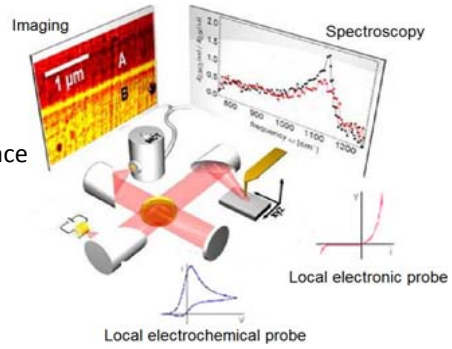
Electrode material



Electrochemical interface



Multi-probe techniques



Develop and deploy novel and unique multi-probe diagnostic systems to study model systems and prototype Li-ion cells

Objectives:

- Unveil the structure and reactivity at hidden or buried interfaces and interphases that determine battery performance and failure modes
- Obtain detailed insight into the dynamic behavior of molecules, atoms, and electrons at electrode/electrolyte interfaces of high voltage Ni-rich NCM cathode materials
  - Understand basic properties and function of interfaces, provide remedies to interface instability.
  - Establish clear connections between diagnostics, theory/modeling, materials synthesis, and cell development efforts
  - Characterize degradation modes

Deliverables:

- Understanding of the underlying principles that govern the function and operation of battery materials, electrodes and cells.
- Develop and apply novel NFIR experimental methodologies.

Funding:

Duration: 4 yrs (Yr 1)
FY16 Budget: $450K (DOE)

Milestones:

- **Q1:** Build and test binder- and carbon-free model NMC electrodes.
- **Q2:** Complete preliminary characterization of interfacial activity of the baseline NMC material in organic carbonate electrolytes
- **Q3:** Determine relationship between surface reconstruction and surface layer formation during cycling in NMC electrodes
- **Q4:** Go/No-Go: Demonstrate feasibility of *in situ* near-filed FTIR microscopy and spectroscopy to study interfacial phenomena at Li-battery electrodes Criteria: Stop development of *in situ* NSOM, if the experiments fail to deliver adequate sensitivity, selectivity and specificity.