**Advanced in situ Diagnostic Techniques for Battery Materials**

**PI/Co-PI:** Xiao-Qing Yang and Xiqian Yu (BNL)

**Technical Approach:**
- Using synchrotron based *in situ* x-ray diffraction technique to study the Fe substituted high voltage spinel during charge-discharge cycling
- Using the combination of *in situ* synchrotron based X-ray diffraction (XRD), x-ray absorption spectroscopy (XAS) and mass spectroscopy (MS) to perform thermal stability and diagnostic studies of new electrode materials.

**Status:**
- Developed new synchrotron based in situ diagnostic tools and applied them to Li-ion battery studies.

**Objectives:**
- Develop new advanced in situ material characterization techniques
- Support the development of new cathode and anode materials for the next generation of lithium-ion batteries for plug-in hybrid electric vehicles

**Deliverables:** Complete and report the studies on:
- *in situ* x-ray diffraction studies on Fe substituted high voltage spinel during charge-discharge cycling
- TR-XRD and TR-XAS studies on structural changes of Li$_{1-x}$Ni$_{1/3}$Co$_{1/3}$Mn$_{1/3}$O$_2$ during high rate charge

**Funding:**
- Duration one year from October 1, 2015
- Total - $600,000.00 DOE - $600,000.00

**Milestones:**
- Q1 Milestone: Complete the thermal stability studies of Fe substituted high voltage spinel cathode materials using time-resolved x-ray diffraction (XRD) and MS techniques.
- Q2 Milestone: Complete the energy resolved transmission X-ray microscopic (TXM) investigation on new concentration gradient NCM cathode sample particles.
- Q3 Milestone: Complete the TR-XRD studies of the structural changes of Li$_{1-x}$Ni$_{1/3}$Co$_{1/3}$Mn$_{1/3}$O$_2$ during high rate charge.
- Q4 Milestone: Complete the TR-XAS studies of the structural changes of Li$_{1-x}$Ni$_{1/3}$Co$_{1/3}$Mn$_{1/3}$O$_2$ during high rate charge.

**Technology:**
- Develop and apply the combination of synchrotron based *in situ* XRD, XAS and MS for diagnostic studies of new electrode materials for lithium-ion batteries.
- Develop and apply transmission X-ray microscopic (TXM) to study concentration gradient NCM cathode mapping by TEM.

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3-D Co, Ni, Mn mapping by TEM