

# Obtaining Theoretical Capacity: Layered Oxide vs. Electrolyte Stability

## Scientific Achievement

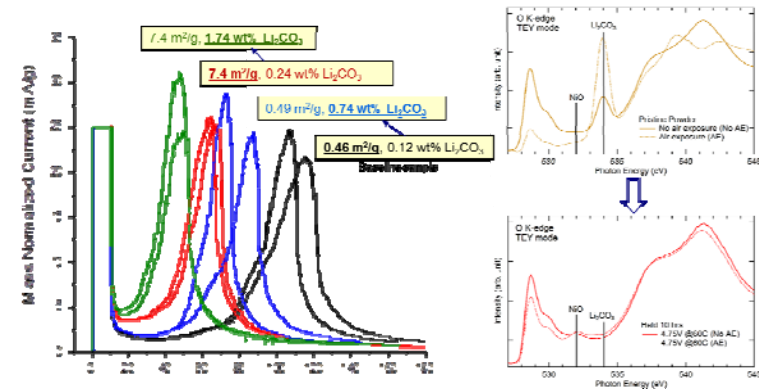
Coupling of electrolyte induced positive electrode surface damage and three modes of impedance development triggered by electrolyte salts, solvents and native surface coatings.

## Significance and Impact

Enables further understanding of decomposition mechanism inducing transport impediment to achievement of full theoretical capacity of NCA

## Research Details

- Prepared fully delithiated NCA positive electrodes
- Isolated transformations to non-cycling induced
- Examined effect of salts, solvents, active materials and native  $\text{Li}_2\text{CO}_3$
- Extensive Characterization used, including
  - Electrochemical Impedance Spectroscopy
  - Operando Electrochemical Microcalorimetry
  - X-ray Photoelectron and absorption spectroscopy
  - High Resolution Transmission Electron Microscopy



**Findings:** High voltage environment at full delithiation creates unique electrochemical environment. Original surface interphases destroyed, reduction of NCA surface by carbonate solvents lead to  $\text{NiO}_x$  surface. Hydrolysis proceeds to induce HF formation and attack of surface leading to excessive dissolution. Native  $\text{Li}_2\text{CO}_3$  enhances dissolution considerably. Solvent and Salt induce contrasting modes of impedance development.

1. N. Faenza, S. Sallis, N. Pereira, Z. Lebens-Higgins, P. Mukherjee, G. Ceder, F. Cosandey, L. Piper, and G.G. Amatucci, Salt and Solvent Induced Phase Transformations of Layered Positive Electrodes, ACS Langmuir, Invited Submission Pending (Fundamental Interface Science for Energy Applications)
2. S. Sallis, N. Pereira, P. Mukherjee, N. F. Quackenbush, N. Faenza, C. Schlueter, T.L. Lee, W. L. Yang, F. Cosandey, G.G. Amatucci, and L.F.J. Piper, "Surface Degradation of  $\text{Li}_{1-x}\text{Ni}_{0.80}\text{Co}_{0.15}\text{Al}_{0.05}\text{O}_2$  Cathodes: Correlating Charge Transfer Impedance With Surface Phase Transformations", Appl. Phys. Lett., 108(6), 262902(1-4) (2016)

Work performed at Rutgers, Binghamton, Berkeley



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science



BINGHAMTON  
UNIVERSITY  
STATE UNIVERSITY OF NEW YORK



UC San Diego



Argonne  
NATIONAL LABORATORY

MIT  
Massachusetts Institute of Technology



Berkeley  
UNIVERSITY OF CALIFORNIA

UIC  
University of Illinois  
at Chicago

UNIVERSITY OF MICHIGAN