# ARGONNE NATIONAL LABORATORY'S POST –TEST FACILITY FOR ANALYSIS OF LITHIUM-ION BATTERY MATERIALS

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Lithium ion batteries are an important energy source with wide scale applications due to their high energy and power densities. As the application of Li-ion batteries has advanced to their use in electric vehicles, the demand for increased performance has led to a greater need to understand the aging mechanisms that reduce storage capacity and increase internal resistance. In order to obtain a comprehensive understanding of the battery aging process, it is imperative to study the physicochemical processes that occur during aging.

Essential to understanding degradation mechanisms is the complete characterization of changes in battery components. Characterization is complicated not only by the complexity of reactions during aging but also by the fact that these materials are air-sensitive and require an inert atmosphere to eliminate artifacts that would lead to misinterpretation of data. To address this issue, Argonne has established a state-of-the-art post-test facility that is capable of analyzing/characterizing battery components in an inert (argon) atmosphere.

Argonne's unique Post-test Facility has two large connected argon-filled glove boxes with water and oxygen concentrations held below 1 ppm. One glove box is used for the dismantling of cells, both large and small, and the subsequent sample preparation for analysis (Figure 1). Samples are transferred to the second customized glove box (via an air-lock) for XPS, Raman FTIR and TGA-MS analysis. Samples for HPLC-MS, GCMS, SEM and TEM are removed from the glove box in containment and analyzed in appropriately modified instrumentation. Additionally, we are capable of TEM sample preparation using ion-milling and ultramicrotomy and we have special air-tight sample holders that allow for analysis at Argonne's Center for Nanoscale Materials user facility using high resolution SEM and Raman with multiple laser sources. In essence, we are capable of systematically studying degradation mechanisms at a multi-scale level. Figures 2 and 3 show TEM and SEM results, respectively, for lithium-ion battery components.


Figure 1. Post-Test Facility argon glove boxes. Cells are dismantled on the right-side glove box, analysis conducted on the left-side glove box.

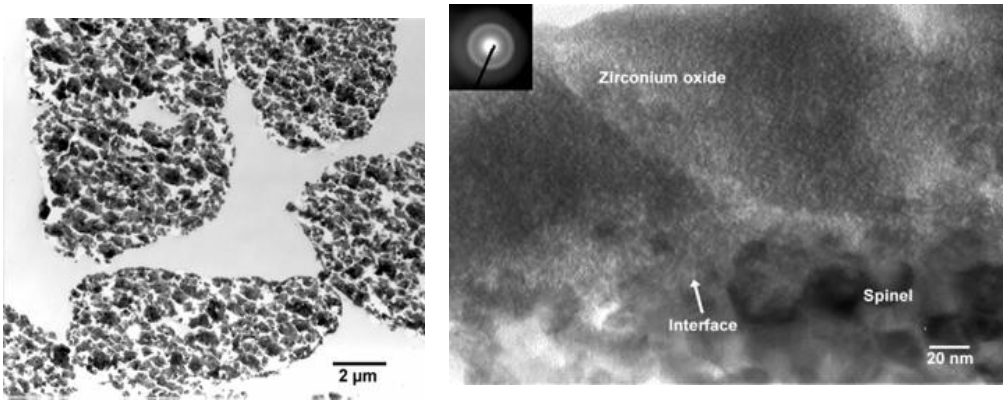


Figure 2. TEM images of ultramicrotomed $ZrO_2$-coated $LiMn_2O_4$ electrode particles, showing amorphous $ZrO_2$ layer over $LiMn_2O_4$ particles.

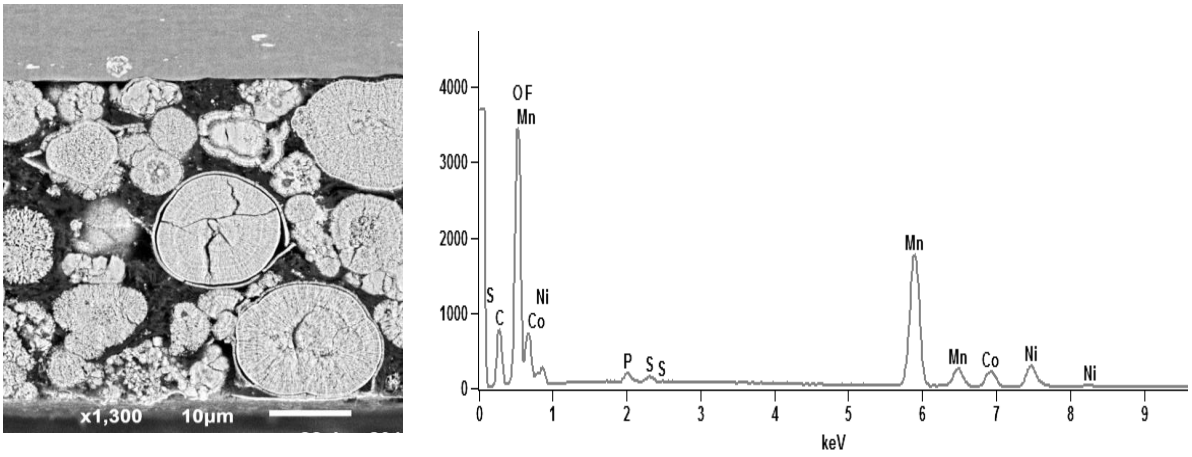


Figure 3. SEM/EDS results from an ion-milled cross-sectioned cathode laminate. The ion-milled surface reveals the internal particle microstructure.

This poster presentation will describe Argonne's Post-Test Facility, with an emphasis on applications and opportunities for collaboration. Cell disassembly, sample harvesting procedures and recent results will be discussed.

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