How batteries grow old: Researchers build facility to put hybrid car batteries to the test

October 20 2010

In a laboratory at Ohio State University, an ongoing experiment is studying why batteries lose their ability to hold a charge as they age -- specifically lithium-ion batteries, which have generated a lot of buzz for their potential to power the electric cars of the future.

Preliminary results presented today at the AVS 57th International Symposium & Exhibition, taking place this week at the Albuquerque Convention Center in New Mexico, suggest that the irreversible changes inside a dead battery start at the nanoscale.

Yann Guezennec and Giorgio Rizzoni of OSU developed new experimental facilities and procedures to charge and discharge commercially-available Li-ion batteries thousands of times over many months in a variety of conditions designed to mimic how these batteries are actually used by hybrid and all-electric vehicles. Some of the batteries were run in hot temperatures like those in Arizona; others in colder conditions similar to those in Alaska.

To understand the results of this testing, Bharat Bhushan, Suresh Babu, and Lei Raymond Cao studied the materials inside of the batteries to help determine how this aging manifests itself in the structure of the electrode materials.

When the batteries died, the scientists dissected them and used a technique called infrared thermal imaging to search for problem areas in each electrode, a 1.5-meter-long strip of metal tape coated with oxide

and rolled up like a jelly roll. They then took a closer look at these problem areas using a variety of techniques with different length scale resolutions (e.g. scanning electron microscopy, atomic force microscope, scanning spreading resistance microscopy, Kelvin probe microscopy, transmission electron microscopy) and discovered that the finely-structured nanomaterials on these electrodes that allow the battery rapidly charge and discharge had coarsened in size.

Additional studies of the aged batteries, using neutron depth profiling, revealed that a fraction of the lithium that is responsible, in ion form, for shuttling electric charge between electrodes during charging and discharging, was no longer available for charge transfer, but was irreversibly lost from the cathode to the anode.

"We can clearly see that an aged sample versus and unaged sample has much lower lithium concentration in the cathode," said Rizzoni, director of the Center for Automotive Research at OSU. "It has essentially combined with anode material in an irreversible way."

This research is being performed by Center for Automotive Research at OSU in collaboration with Oak Ridge National Laboratory and the National Institute of Standards Technology.

The researchers suspect, but cannot yet prove, that the coarsening of the cathode may be behind this loss of lithium. If this theory turns out to be correct, it could point battery manufacturers in the right direction for making durable batteries with longer lifetimes.

More information: The presentation, "Multi-scale Characterization Studies of Li-ion Batteries" is at 6:00 p.m. on Tuesday, October 19, 2010. ABSTRACT: www.avssymposium.org/Open/Sear … PaperNumber=AS-TuP-9

Provided by American Institute of Physics