



New generation batteries

Using the *power* of materials engineering

Rechargeable batteries store energy produced by power companies for use in a myriad of mobile devices. Not just for entertainment, medical devices such as implantable defibrillators and cochlear implants must also have a mobile power supply. On top of a growing need for batteries that can be used to reliably power small devices, there is also a need for large, rechargeable batteries in hybrid electric vehicles.

Steve Hackney investigates materials for use in advanced energy storage systems—aka batteries.

His research team collaborates with investigators from national labs, industry, and other universities to solve the important problem of materials degradation in rechargeable lithium ion batteries.

“We’re always looking for ways to improve the performance of battery electrode materials,” Hackney explains. “Materials structure changes during the charge/discharge cycle is what cause batteries to fade. From a microstructural point of view, there are still many unanswered questions about how and why electrode materials degrade during service.”

Hackney and his team study battery electrodes made of cobalt and manganese lithium oxides, metal alloy, and metal/carbon composites using high-resolution transmission electron imaging and convergent beam electron diffraction.

Successful battery chemistry requires that electrode materials hold up to repeated changes in volume and crystal structure during the charge/discharge cycle. “This is needed to avoid the loss of the mechanical integrity of the electrode,” says Hackney. “Battery materials investigation involves a unique, multi-disciplinary approach, one involving crystal structure analysis, thermodynamics, kinetics and mechanics.”

Over the years, Hackney helped develop a specific strategy for electrode materials development, engineering the material structure and chemistry on a nanometer scale. One such nano-composite approach is now being pursued in an attempt to increase the electrical capacity per unit volume by a factor of 1.5 to 2 in the positive electrode. “This is accomplished by combining small amounts of low capacity, stable crystal structures with high capacity unstable crystal structure,” Hackney explains. “To be effective, this combination of phases must occur at the atomic scale.”

More recently, a group of Michigan Tech faculty has developed an education program in vehicle electrification. “My part is to educate engineers on how the battery is developed for—and how it behaves within—the electric or hybrid drive train system. Based on what I am seeing in terms of industry needs, I believe a whole new research and engineering development effort is required to understand how the electric vehicle drive train control strategy effects battery performance and lifetime, and in turn how the control system must be recalibrated as the long and short term battery performance changes.”



Steve Hackney
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Pictured: Convergent Beam Electron Diffraction (CBED) of a new generation Li primary battery cathode material

