

## Electrochemical Energy Storage

Argonne National Laboratory has been actively involved in the development of advanced batteries since the late 1960s when it initiated R&D on high-temperature lithium sulfur batteries. In the early 1970s, the US Department of Energy (DOE) established its first independent battery test facility at Argonne and named it the National Battery Test Laboratory (NBTL), for the purpose of conducting independent evaluations on advanced battery technologies that were potential candidates for use in battery-powered electric vehicles. NBTL incorporated a well equipped post-test analysis laboratory that was instrumental in helping to identify life-limiting mechanisms with several candidate battery technologies. Even in these early days of the battery program, Argonne was internationally respected for its advanced battery work. Over the last 40 years Argonne's battery program has evolved and expanded, becoming internationally recognized as a world-class center for lithium battery R&D.

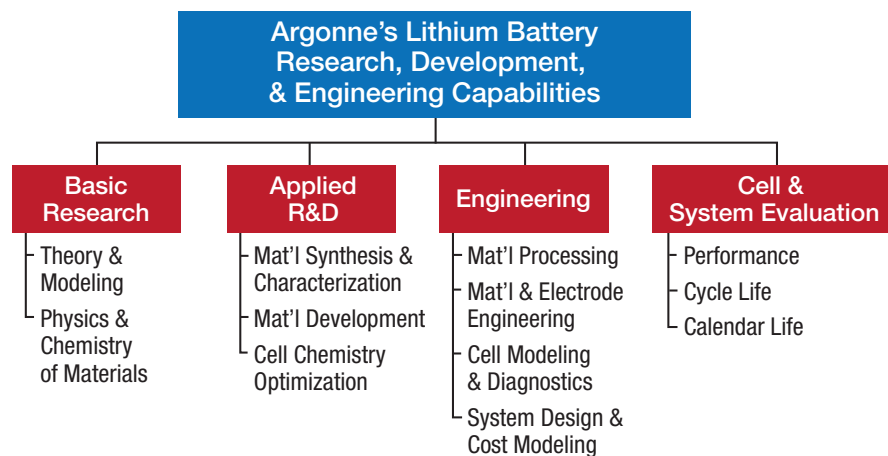


*Examining a lithium-ion battery cell at the Battery Test Facility.*

The department's three R&D groups cover the lithium battery landscape from the basic science perspective to the engineering design of batteries for specific applications. This integration of basic research, applied R&D, and engineering (as shown below) has played a key role in Argonne's success.

### **Integrating Basic Research, Applied R&D, and Engineering**

The current organization of Argonne's Electrochemical Energy Storage Department includes a battery test group and three battery R&D groups. The battery test laboratory changed its name to the Electrochemical Analysis and Diagnostic Laboratory (EADL), but it continues to provide DOE's transportation program and US auto companies with the same type of independent evaluations, using standardized test protocols that EADL helped to develop for DOE.



## Electrochemical Energy Storage

The integrated capabilities of the department can be described using an example of the process it employs to develop more optimal materials and cell chemistries for a specific application. When existing cell chemistries suffer from life, inherent safety, or performance limitations, detailed diagnostic and electrochemical cell modeling studies are used to identify the limiting factors and new materials are developed to overcome these limitations. These can be new electrode materials with enhanced structural, chemical, electrochemical, and thermal stability that are designed (with the aid of ab initio modeling) to increase specific capacity, extend life, and/or enhance inherent safety. Additionally, with the aid of quantum mechanical modeling, electrolyte additives with the proper redox potentials and physicochemical properties are developed to help stabilize the electrode/electrolyte interfaces. These new materials are thoroughly characterized and compared with existing materials to provide assurance that they will help stabilize cell chemistry. Once the characterization work and preliminary aging studies verify enhanced stability, the materials are produced in sufficient quantity to allow thorough evaluations in hermetically sealed cells, which are obtained from industrial battery manufacturers. Argonne employs its detailed battery design model to develop the electrode design specifications, and the battery manufacturer coats electrodes and produces cells to Argonne's specifications. These hermetically sealed cells are then subjected to extensive accelerated aging and abuse tests to quantify the improvements relative to a baseline cell chemistry. Results from detailed diagnostic and modeling studies on these cells are then used to further refine and

optimize the materials, if needed. Using this process, Argonne has developed a large [portfolio of intellectual property](#) on advanced materials that is available for licensing by the battery industry and its material suppliers.

### Leading Major DOE Initiatives

Argonne is DOE's lead laboratory for its applied battery R&D program for hybrid electric vehicle (HEV) applications, the Advanced Technology Development (ATD) program. This program is a multi-laboratory program that involves support from four other DOE national laboratories: Brookhaven, Idaho, Lawrence Berkeley and Sandia. The objective of this program is to help the industrial developers of Li-Ion batteries to overcome the key barriers of calendar life, abuse tolerance, low-temperature performance, and cost for Li-Ion batteries in HEV applications. Also, Argonne is a major participant in DOE's longer-range R&D program, the Batteries for Advanced Transportation Technologies (BATT) program. Here Argonne's role is in the development of novel anode and cathode materials that can help advance Li-Ion battery technology for transportation applications. DOE also is looking to Argonne's Electrochemical Energy Storage Department to make significant contributions to its new initiative on plug-in hybrid electric vehicles (PHEVs). Argonne is (1) testing prototype PHEV cells to establish baseline performance characteristics and to aid in the development of standardized PHEV testing protocols, (2) developing PHEV battery performance models that are used in PHEV vehicle simulation studies, and (3) conducting R&D on

new advanced electrode materials, with the goal of significantly increasing the energy density of lithium-ion batteries for this application.

### Working with Others

In addition to projects funded directly by DOE projects, Argonne conducts R&D for industrial firms under Work for Others contracts. Some of these contracts involve R&D support to industrial battery companies that are funded by DOE via its collaborative R&D agreement with the U.S. auto companies (the U.S. Advanced Battery Consortium). Other contracts are with industrial firms that seek Argonne's help to develop and optimize cell materials, components, and/or cell chemistries for a variety of applications.

To further support advanced battery research, Argonne's [Electrochemical Analysis and Diagnostics Laboratory](#) is available to assist Argonne and non-Argonne battery researchers by conducting evaluations that can be used to identify potential design or material changes that may improve battery performance. EADL conducts independent performance and life studies on DOE/USABC contract deliverables and similar benchmark studies on advanced battery technologies developed without DOE support. Services of this type also are available to the private sector.

For further information, please contact

Gary Henriksen, Manager  
Electrochemical Energy Storage  
Chemical Sciences and  
Engineering Division  
Argonne National Laboratory, Bldg. 205  
9700 South Cass Avenue  
Argonne, IL 60439 USA  
630-252-4591  
henriksen@anl.gov

April 2009



U.S. DEPARTMENT OF  
**ENERGY**

Argonne National Laboratory is a  
U.S. Department of Energy laboratory  
managed by UChicago Argonne, LLC