Developing Safe, High-Performance Batteries for Advanced Vehicles

Rechargeable lithium batteries are being considered for transportation applications, where high energy, high power, and long life are needed. At Argonne National Laboratory, researchers are advancing lithium battery technologies for electric and hybrid electric vehicles. Promising battery technologies are being tested in Argonne's Electrochemical Analysis and Diagnostics Laboratory (EADL), which also provides independent, standardized testing for all types of fuel cells for U.S. Department of Energy (DOE) and fuel cell developers.

Advanced Lithium-Polymer and Lithium-Ion Batteries

In the 1990s, Argonne helped its industrial partners develop lithium-polymer batteries for electric vehicles. A major accomplishment was the development of a superior positive-electrode material with 30% higher capacity density and a lower irreversible capacity loss upon cycling. Since 1998, Argonne has led a major program–involving five U.S. Department of Energy (DOE) laboratories–to assist the industrial developers of high-power lithium-ion batteries overcome the key barriers of calendar life, cost, and abuse tolerance for this technology. Accelerated aging, safety characterization, and diagnostic studies have led to an understanding of the factors that control calendar life and abuse tolerance. Using this knowledge, researchers are developing new lower-cost, more stable electrode materials and electrolyte systems to simultaneously address these three key barriers. These materials include a family of stable low-cost, high-rate cathode materials, as well as electrolyte additives that enhance the inherent safety and extend the calendar life of cells. Additionally, low-cost, long-life flexible cell packaging technology is being developed to replace the expensive metal can and glass-to-metal feedthrough technology. Numerous patent applications are being filed on these and related technologies.

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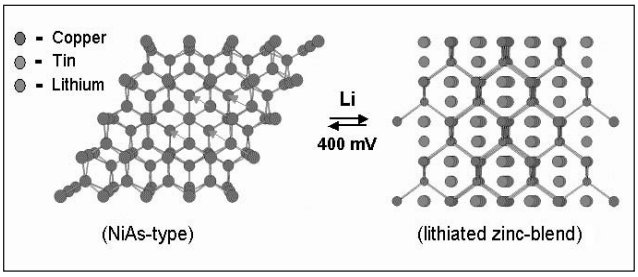
Prototype lithium-ion battery pack developed by Argonne. Researchers are working to develop a new class of intermetallic electrode materials for lithium-ion batteries that offer greater safety and improved performance.

Advanced Electrode Materials

A need exists for alternative electrode materials that reduce the safety hazards and improve the performance of lithium-ion batteries. Argonne research is focusing on a new class of intermetallic materials with nickel arsenide and zinc-blend-type structures. These materials react electrochemically with lithium at a few hundred millivolts above the potential of metallic lithium. Results of the research to date hold great promise for developing an alternative electrode that is safe and able to endure many cycles without capacity decline.



The reversible topotactic transition of Cu_6Sn_5 (left) to Li_2CuSn (right) during which 50% of the Sn atoms are displaced into interstitial sites on insertion of lithium.

In another development, Argonne researchers have discovered that layered lithium metal oxide electrodes $LiMO_2$, in which M is typically manganese and nickel, can accommodate additional lithium to yield the composition Li_2MO_2, without destroying the structural integrity of the layered electrode. These highly lithiated structures are attractive as reservoirs for lithium to counter irreversible capacity losses that commonly occur during the initial charge and discharge of conventional lithium-ion cells.

Patent applications have been filed for these Argonne technologies.

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For more information about battery testing and evaluation in the EADL, contact Ira Bloom, phone: (630) 252-4516.

Argonne National Laboratory is operated by The University of Chicago for the U.S. Department of Energy