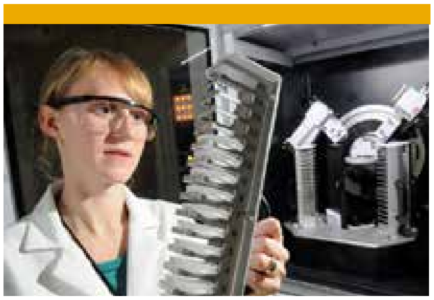
THE BEST X-RAY TOOLS FOR BATTERY DEVELOPMENT AND TESTING

Industry and academia accelerate innovation using the Advanced Photon Source at Argonne National Laboratory



An Argonne researcher loads a sample mount of battery cathode materials for X-ray diffraction, an analysis tool for obtaining information on the crystallographic structure and composition of materials.

CATHODES AND HIGH VOLTAGE PERFORMANCE

Researchers used the APS and a powerful diffraction X-ray imaging technique combined with new data analysis algorithms to gain insights — at the nanoscale level — on the mechanical properties of a cathode material called an LNMO spinel (composed of lithium, nickel, manganese and oxygen atoms).

The research reveals how the cathode material behaves while the battery charges and offers a possible explanation for why this particular cathode material works well at high voltage levels, an attribute that is crucial for batteries used in high-power applications such as electric cars.

Defects in the cathode material appear as irregularities in the otherwise highly ordered atomic structure. Imaging and data analysis techniques identified and located the defects which could lead to new strategies for discovering how other cathode materials behave at the nanoscale level while batteries are charging.

NEW CATHODE MATERIAL POWERS CHEVY VOLT

Five companies—including General Motors, Envia Systems, and BASF—licensed battery cathode material developed at Argonne using X-ray absorption scattering at the APS. This cathode material has been used in dozens of applications including the Chevy Volt battery.

X-ray analysis provided critical information on the cathode structures and chemical reactions in operating lithium ion batteries. This led to the development of manganese- and lithium-rich cathode materials that made the batteries more cost effective to manufacture, safer, and longer lasting.

OPTIMIZED CHEMISTRY RESULT IN GE'S DURATHON BATTERY

Scientists from GE developed new battery chemistry with the help of scattering and pair distribution function X-ray techniques at the APS. This led to an understanding of the mechanism by which sodium batteries discharge and store energy.

The APS's high-energy X-rays provided penetration power combined with a small focusing area to see into the battery cells and map chemical distributions and reactions under actual operating conditions. The knowledge gained through X-ray analysis helped GE improve battery capacity, power, and safety.

GE leveraged this knowledge to fine-tune the development of Durathon, a new long-life battery for utility systems and electric vehicles. This new battery design enables optimal charging and discharging times even in extreme temperatures. This enables operation without installation of expensive controlled environments.

PIONEERING MULTIVALENT BATTERY POTENTIAL

Multivalent ions are promising battery chemistry candidates for creating batteries with higher energy densities (watt hours). Understanding the chemical reactions, solubility and ion transfer to electrodes at the atomic scale are crucial to the future development of a multivalent battery.

An experimental approach using the APS and scattering and pair distribution functions revealed the structure and energetics of Mg^{++} ion solvation in a diglyme electrolyte. This discovery — achieved by a team of researchers working as part of the Joint Center for Energy Storage Research (JCESR) — identifies a new design target for multivalent battery electrolytes. JCESR is a consortium of industries, universities, and national laboratories.

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