Argonne electrifies energy storage research

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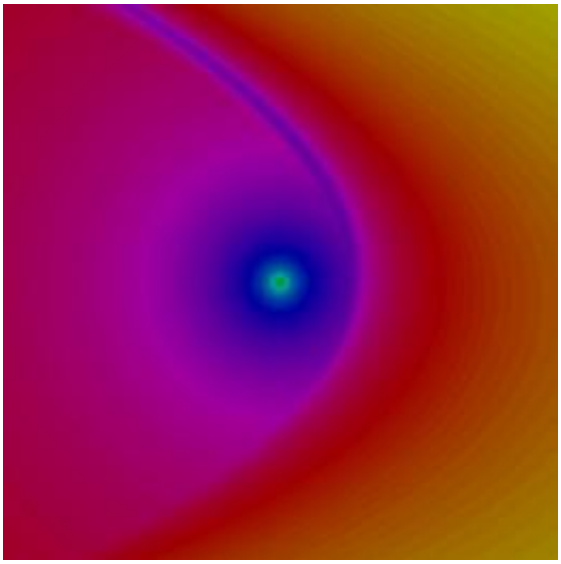

Energy storage research visualized: Scalar potential of a point charge shortly after exiting a dipole magnet, moving left to right.

A multidisciplinary team of researchers at Argonne National Laboratory is working in overdrive to develop advanced energy storage technologies to aid the growth of a nascent U.S. battery manufacturing industry, help transition the U.S. automotive fleet to one dominated by plug-in hybrid and electric passenger vehicles, and enable greater use of renewable energy technologies.

"Argonne has had some notable advanced battery technology development successes," said Argonne Director Eric Isaacs. "Our scientists have successfully developed 150 advanced battery technologies

in the last decade. In more recent years, we've executed several licensing deals for a lithium-ion battery technology with General Motors, BASF, Envia, LG Chem and Toda America. We'll continue to develop and license more advanced battery technologies for transportation use, but our four decades of battery research experience has shown us that there is more that we can do, given the increasing demand for energy worldwide and concerns about energy's impact on the climate.

"So a couple of years ago," Isaacs added, "Argonne decided to expand into another critical energy research area—large-scale energy storage for electric utility applications that will enable greater adoption of renewable energy technologies like wind and solar without compromising the reliability of the nation's electricity grid. We are in the beginning stages of that research. At the same time, Argonne also wanted to ensure that the advanced technologies being developed here and elsewhere have an easier time of finding their way into the marketplace and real-life use."

Under Argonne's new Energy Storage Initiative (ESI), the laboratory's battery program aims to cover a broad array of advanced energy storage research from basic materials and cell engineering and design to testing and validation, said Jeff Chamberlain, who heads the initiative. The initiative reaches across all of the laboratory's research directorates and scientific user facilities to deliver technologies that are built on a solid foundation of basic research.

In practical terms, for example, that means an Argonne scientist might first uncover new knowledge about the function of a material as an electrical charge passes through it. Using this new knowledge a scientist would perform limited exploratory lab experiments on the new material to establish reproducible performance. If the performance addresses a market need, engineering science is conducted to enable production scale-up of the new material.

"Fortunately," Chamberlain said, "at Argonne we have powerful scientific tools like the Advanced Photon Source (APS), whose X-ray beams allow us to make the closest possible examination of the new material and determine how it works, reacts, changes and recovers under various conditions. We also capitalize on the powerful tools of our many collaborators, like Brookhaven and Pacific Northwest national laboratories and the University of Illinois, Urbana-Champaign."

Building on this foundational research, scientists and engineers make commercial-grade prototype battery cells and map out the various factors involved in making the battery material work. During the entire R&D process, basic and applied researchers are able to move back and forth between any of the basic research and applied research steps in order to fully understand the novel material.

"Bear in mind that the scientific research we perform is aimed to benefit the citizens who have invested in the research with their tax dollars," Chamberlain said. "Our objective, then, is to aim our research to enable U.S. economic growth and energy security. To achieve this goal, the U.S. Department of Energy (DOE) and Argonne consult heavily with and sometime work directly with industry to ensure the R&D we perform can be properly capitalized on."

Moreover, when a technology's potential for market adoptability is strong, "it is part of our job to help industry develop it to the point where it can be commercialized," he said. That critical portion of the technology-transfer equation is now being addressed.

When industry identifies an innovation that has clear benefit and can be manufactured, it's part of our job to perform the engineering research to get out of the 'valley of death.'

For research purposes, scientists need only enough material—10 to 100

grams—to fill battery cells the size of a button, but manufacturers require tens of kilograms for pre-commercial validation testing. This is one of the biggest challenges of many new innovations.

"The engineering problem associated with scaling up production of a material to a kilogram is different than understanding how a material functions," Chamberlain said, "and the engineering problems must be addressed to enable validation of a material and understand its true performance."

With funding support from DOE and the U.S. Department of Defense, Argonne is building a Materials Engineering Facility (MEF) to scale-up production of new materials. Not only does MEF greatly reduce the time needed to produce larger amounts of novel materials, but the facility's researchers develop engineering processes to reduce cost and materials waste. Although construction of the facility is not yet complete, researchers have, in their interim facility, successfully developed—in less than six months—a process to make an innovative Argonne-developed material that provides battery overcharge protection more economically and with less waste.

Argonne also partnered with the Commonwealth of Kentucky in 2009 to establish the Kentucky-Argonne National Battery Manufacturing Research and Development Center, which will provide a domestic source of trained engineers, scientists and technicians with expertise and skills in battery manufacturing. Construction of the center's building will be completed by December, and it will be fully operational by early 2013.

"Implementation of the Energy Storage Initiative has certainly positioned the lab to perform the broadest known array of energy storage research," Chamberlain said. "And we're already seeing the benefits from it."

Provided by Argonne National Laboratory