DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

Coming Soon: Protons in 3-D

A CT scan transforms 2-D x-rays into 3-D images of the human body. At DOE's Jefferson Lab, physicists are using the same principle to peer at the guts of the proton. Using a process called deeply virtual Compton scattering, a recent experiment tested whether it was possible to access Generalized Parton Distributions (GPDs). GPDs are mathematical functions that will one day allow physicists to make a 3-D map of the location and momentum of the proton's building blocks: quarks and gluons. This first experiment dedicated to GPDs revealed that an essentially holographic picture of the proton is indeed within reach.

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International program studies hydrogen storage material safety

A four-year international program led byDOE's Savannah River National Laboratory will provide vital information on the safety of new materials being considered for solid-state hydrogen storage. Through a variety of modeling, sub-scale demonstrations and physical testing, the international consortium will identify and quantify risks and mitigation strategies for these new, nontraditional hydride materials. "Fundamental Safety Testing and Analysis of Hydrogen Storage Materials & Systems," led by SRNL's Don Anton, was formally recognized and endorsed by the Steering Committee of the International Partnership for the Hydrogen Economy at its meeting in Reykjavik, Iceland last Fall. Partners include AIST (Japan), FZK (Germany), Sandia National Laboratories, University Quebec-Three Rivers and United Technologies Corp.

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Sandia researchers help understand climate change

Mark Ivey and Bernie Zak of DOE's Sandia National Laboratories are members of an international research team whose DOE-sponsored work on Alaska's North Slope is helping to transform scientists' understanding of what the future may hold for Earth's climate. Their work accords researchers with a rare, ground-based window into the cloud and radiative processes that take place in the atmosphere at high latitudes. The North Slope will serve as a center for atmospheric and ecological research activity during the International Polar Year 2007-08, focusing on Arctic scientific activities, while scientists from around the world will focus research on both the Arctic and the Antarctic.

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Rapid, automated identification of radionuclides

A fully automated process monitor developed at DOE's Pacific Northwest National Laboratory can identify and quantify specific alpha- and beta-emitting radionuclides in solutions in a manner of minutes. The prototype system would address industry's need for accurate, reliable and real-time analysis of samples taken directly from a processing line.

PNNL's device provides microwave-assisted sample pretreatment, flexible chemical separations capabilities, sensitive radiochemical detection, calibration and data analysis. Samples can be adjusted, separated and analyzed in less than 15 minutes to provide feedback on process performance.

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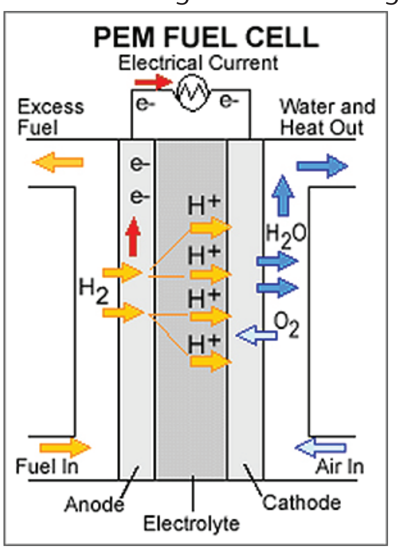
DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. *DOE Pulse* (www.ornl.gov/news/pulse/) is distributed every two weeks. For more information, please contact Jeff Sherwood (jeff.sherwood@hq.doe.gov, 202-586-5806).

A boost for hydrogen fuel cell research

The development of hydrogen fuel cells for vehicles, the ultimate green dream in transportation energy, is another step closer. Researchers with DOE's Lawrence Berkeley National Laboratory and Argonne National Laboratory have identified a new variation of a familiar platinum-nickel alloy that is far and away the most active oxygen-reducing catalyst ever reported. The slow rate of oxygen-reduction catalysis on the cathode—a fuel cell's positively charged electrode —has been a primary factor hindering development of the polymer electrolyte membrane (PEM) fuel cells favored for use in vehicles powered by hydrogen.

"The existing limitations facing PEM fuel cell technology applications in the transportation sector could be eliminated with the development of stable cathode catalysts with several orders of magnitude increase in activity over today's state-of-the-art catalysts, and that is what our discovery has the potential to provide," said Vojislav Stamenkovic, a scientist with dual appointments at Berkeley Lab and Argonne.



PEM fuel cells generate an electrical current with only heat and water as a by-product.

Stamenkovic and Argonne senior scientist Nenad Markovic led a study in which pure single crystals of platinum-nickel alloys were created across a range of atomic lattice structures in an ultra-high vacuum (UHV) chamber. A combination of surface-sensitive probes and electrochemical techniques was then used to measure the respective abilities of these crystals to perform oxygen reduction reaction (ORR) catalysis. The ORR activity of each sample was then compared to that of platinum single crystals and platinum-carbon catalysts. The researchers identified the platinum-nickel alloy configuration Pt3Ni(111) as displaying the highest ORR activity that has ever been detected on a cathode catalyst —10 times better than a single crystal surface of pure platinum(111), and 90 times better than platinum-carbon.

Submitted by DOE's Lawrence Berkeley National Laboratory

ORNL's Zinkle tackles materials challenges

Steve Zinkle

The fusion reactors that will someday power the electric grid and interplanetary spacecraft that will explore the solar system represent some of science's toughest materials challenges. Steve Zinkle has spent more than two decades at DOE's Oak Ridge National Laboratory studying radiation's effects on materials toward developing advanced materials for these missions.

The UT-Battelle corporate fellow and Materials Science & Technology Division director says knowing the physical processes behind and nature of the damage is critical to the development of the high-performance, degradation-resistant materials required for fusion reactors and for fission-powered spacecraft.

"I've spent a majority of my research career on fusion material—20 years or so—investigating the physical phenomena responsible for radiation damage; to understand it well enough to prevent undesirable degradation from happening in suitably designed materials," the materials scientist says.

"Fusion creates one of the most hostile environments imaginable—a fusion reactor is a miniature sun surrounded by earthly materials," Zinkle says. "Nuclear transmutation reactions and radiation damage events that would never happen with fission can become a big problem for fusion materials," he says.

The space reactor program presents fission materials problems. The power systems now in space service generate just a few kilowatts. If we want to explore the solar system in more depth—for example, investigate the frozen oceans on Jupiter's moon Europa and transmit reams of scientific data back to Earth, or establish human research bases on the moon or Mars, the spacecraft will need more power.

The keys to developing more robust space reactors that can stand the radiological stresses and are sleek enough to launch on a rocket lie in advanced materials.

Zinkle's contributions were recognized recently as he received DOE's prestigious E.O. Lawrence Award.

Submitted by DOE's Oak Ridge National Laboratory