Ames Laboratory's Dan Schechtman

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Research Highlights . . .

Automated, nondestructive inspection system characterizes atomic-level properties

Researchers at DOE's Idaho National Laboratory have developed the Portable Positron Measurement System (PPMS), which non-destructively tests materials at the atomic level throughout the production process. PPMS provides feedback and control capabilities during high-temperature fabrication, solidification and heat treatment. It uses photon-induced positron annihilation to ascertain material properties. Simultaneous manufacturing and monitoring were previously prevented by the complex interplay of temperature, time at temperature, cooling rates, heat treatments, and strain reduction during fabrication and heat treatment. PPMS provides access to this information as a product is formed.

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Scientists capture 3D images of 'frozen smoke'

Researchers have created a three-dimensional image of a material referred to as "frozen smoke." Aerogel is an open-cell polymer with pores smaller than 50 nanometers in diameter. For the first time, DOE's Lawrence Livermore and Lawrence Berkeley scientists have peered into this material and created three-dimensional images to determine its strength and identify potential new applications. Aerogel is an engineered material that can be used as catalysts for cleaner fuels and for the diffusion of water and oil in porous rocks.

"By imaging an isolated object at high resolution in three dimensions, we've opened the door to a range of applications in material science, nanotechnology and cellular biology," LLNL scientist Anton Barty said.

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NETL adopts medical technique to study mobility of CO_2 in coal

DOE's National Energy Technology Laboratory (NETL) is using computed tomography (CT), usually a medical technique, to assess the potential long-term storage of carbon dioxide (CO_2) in deep, unmineable coal seams. CO_2 concentration gradients were determined at the confining and pore pressures of the deep strata. This technique provides realistic and essential design information regarding flow and sorption rates and limits of CO_2 sorption. The data can be used in numerical simulations to predict results for target coal seams. A paper describing the approach and the observed results has been accepted for publication in the peer-reviewed journal, SPE-Reservoir Evaluation & Engineering-Reservoir Engineering.

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Wireless networks improve by "hops" and bounds

With the potential to improve gas and oil pipeline monitoring, disaster recovery, and border surveillance, wireless ad-hoc and sensor networks hold the promise of extending our senses into the world, far beyond what is now possible. Instead of relying on a central base station as cellular networks do, these untethered devices—often called "motes"—use each other to transmit information through a series of "hops," making the networks more versatile and mobile. Sami Ayyorgun of DOE's Los Alamos National Laboratory has come up with a scheme that shows for the first time that significant gains in many aspects of performance are possible, including connectivity, energy, delay, throughput, system longevity, coverage, and security.

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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).

NETL researchers participate in key methane hydrate R&D expeditions worldwide

By 2015, the Department of Energy plans to initiate the commercial production of methane hydrates, an ice-like structure that contains trapped methane molecules. The energy content of methane in hydrate is estimated to be greater than that of all other known fossil fuels combined. As such, expeditions to evaluate the arctic and deep oceans where hydrates occur are critical to advancing understanding of these methane-rich accumulations.

Back from a recent three-week ocean expedition near Vancouver Island off the British Columbia coast, geologist Kelly Rose of the DOE's National Energy Technology Laboratory and her fellow researchers collected over 1,800 samples and approximately 50 kilometers of geophysical surveys in one more step toward understanding the role of methane hydrate in the natural environment.

This expedition included researchers from the Geological Survey of Canada, United States Geological Survey, McGill University, and DOE. Rose provided shipboard sedimentology support and NETL Methane Hydrates Graduate Research Fellow Laura Lapham participated as a member of the shipboard geochemistry team.

NETL directly manages two large-scale field projects that ultimately seek to test gas hydrate produceability in marine and arctic environments. The BP-DOE Alaska North Slope project drilled and executed a short-term test of hydrate-bearing sands in 2007. Among the on-site science team were NETL researchers Rose, Ray Boswell, and Eilis Rosenbaum, and as a result of that success, a future exploration well, including a production test, is under development. In FY09, the NETL supported Chevron-Texaco Joint Industry Project is set to evaluate three sites for future drilling and coring activities in the Gulf of Mexico (GOM)

Over the past two years, Rose, team leader for NETL's methane hydrate field studies program, has participated in six gas hydrate field expeditions including those in the South China Sea, South Korea's East Sea, offshore the Cascadia margin, and the GOM. Rose and Boswell also served as members of the science team during the 2006 Indian Ocean expedition.

These expeditions, in conjunction with extensive laboratory and computational research, move the research effort a step closer to DOE's goals of determining whether sufficient quantities of methane hydrate exist to provide 10 percent of the nation's gas supply by 2010. If that quantity exists, then DOE can proceed to commercial production by 2015.

Submitted by DOE's National Energy Technology Laboratory

Quasicrystal founder gets his due

Dan Schechtman

Scientific discovery is always met with a certain amount of skepticism. But Ames Laboratory scientist Dan Schechtman could hardly have been prepared for the backslash he received back in 1982 when he announced he had found the icosahedral phase in rapidly solidified aluminum transition metal alloys, which opened up the field of quasi-periodic crystals as an area of study in materials science.

Shechtman's discovery represented a paradigm shift in what had, until the early 1980s, been considered conventional wisdom in the science of crystallography: namely, that the atoms and molecules of all crystals are arranged in ordered, repeating patterns that extend in all three dimensions. However, by using electron diffraction rather than the more widely accepted application of X-ray diffraction, Shechtman discovered a limited class of crystals that, unlike normal crystals, demonstrate an icosahedral phase, making them only quasi-periodic.

Initially resisted by the scientific community, including a denunciation by two-time Nobel-prize winner Linus Pauling, Shechtman's discovery of quasicrystals fundamentally altered the science of crystallography. And although it took almost a decade for the significance of quasicrystals to be recognized, within 10 years the International Union FO Crystallographers acknowledged the scope of Shechtman's achievement, and officially changed the definition of what constituted a "crystal" in the scientific literature.

Schechtman, who is also a professor in the Department of Materials Science and Engineering at Iowa State University, received further vindication this past spring, as the 2008 recipient of the European Materials Research Society award.

The award, which is presented only once every five years, is the highest recognition conferred upon a materials scientist by the society, which is Europe's leading organization for the support and advancement of research in materials. Shechtman was formally recognized with the award at a ceremony and banquet in Strasbourg, France, in May.

Submitted by DOE's Ames Laboratory