SRNL's Alfred Garrett

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DOE Pulse

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Research Highlights . . .

Scanning the microworld: SSRL's new X-ray microprobe

Researchers have long used x-rays as a tool for studying environmental contaminants. Now, thanks to a new U.S. DOE BER-funded microprobe at the Stanford Synchrotron Radiation Laboratory's beamline 2-3, unlocking the secrets of how these contaminants behave on a molecular level is getting both easier and more accurate. Unlike other x-ray techniques that look only at overall compositions of a sample, the new microprobe allows a sample to be moved around, creating detailed picture of where certain compounds lie. A pair of focusing mirrors form the core of the new microprobe, squeezing the beam down to a two-micron spot (50 times smaller than a strand of hair, and the same size as many biological cells).

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Night of the living enzyme

Inactive enzymes entombed in tiny honeycomb-shaped holes in silica can reactivate, scientists at DOE's Pacific Northwest National Laboratory discovered. The enzymes perked up when entrapped in a nanomaterial called functionalized mesoporous silica, or FMS. The FMS pores mimic the crowding of cells. Crowding, said the PNNL team, authors of a recent paper in the journal *Nanotechnology,* seems to induce an unfolded, free-floating protein to refold; upon refolding, it reactivates and becomes capable of catalyzing thousands of reactions a second. The finding opens up new possibilities for exploiting these enzyme traps in pursuits that require controlling catalysts and sustaining their activity.

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Sandia simulation monitors trafficking in contraband nuclear material

A researcher at DOE's Sandia National Laboratories has developed a simulation program designed to track the illicit trade in fissile and nonfissile radiological material well enough to predict who is building the next nuclear weapon and where they are doing it. David York collected and collated data from 800 open-source incidents from 1992 to the present, along with the movement of dual-use items like beryllium and zirconium. He plotted the incidents on a geographic information system (GIS) software platform. He came up with a network of countries and routes between countries indicative of an illicit nuclear and radiological trafficking scheme.

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Atom-scale switch

Researchers at DOE's Oak Ridge National Laboratory have discovered a carbon nanotube-based system that functions like an atom-scale switch. Their approach is to perform first-principles calculations on positioning a molecule inside a carbon nanotube to affect the electronic current flowing across it. The result is an electrical gate at the molecular level: In one position, the molecular gate is open, allowing current through; in another position, the gate is closed, blocking the current. In a silicon chip, the gate is a silicon oxide barrier within the structure of the chip. In the ORNL model, the gate is a short molecule—encapsulated inside the carbon nanotube—that is about one nanometer in size, or three orders of magnitude smaller than a silicon chip. The paper is slated to appear in the Feb. 2 *Physical Review Letters*.

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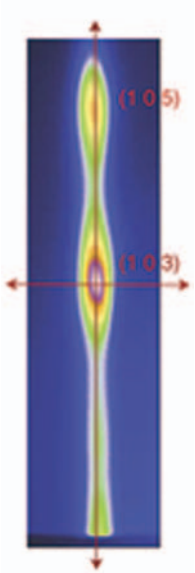
DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. ***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).

An insulating breakthrough

A new insulating material with the lowest thermal conductivity ever measured for a fully dense solid has been created at the University of Oregon (UO) and tested at DOE's Advanced Photon Source at Argonne National Laboratory. The research was carried out by collaborators from the UO, the University of Illinois at Urbana-Champaign, the Rensselaer Polytechnic Institute, and Argonne. The principles involved, once understood, could lead to improved insulation for a wide variety of uses, the scientists say.



False-color depiction of the x-ray diffraction intensities collected by the area detector in the vicinity of the (1 0 3) and (1 0 5) reflections. Image courtesy of Science Magazine.

"The reason for the extraordinarily low thermal conductivity that we've now achieved is an unusual structure which is crystalline in two directions but has a subtle rotational disorder in the direction of low-heat conduction," David C. Johnson, a professor of chemistry at the University of Oregon and member of the UO Materials Science Institute.

The material prepared in Johnson's lab "is the closest thing that anyone has found to making a dense solid into a perfect thermal insulator," said co-author and corresponding investigator David G. Cahill, a professor of materials science and engineering at the University of Illinois at Urbana-Champaign. "This new physical properties displayed by this material might some day point the way toward methods of creating more effective practical insulations."

"Thermal conductivity is an important property in both conserving energy and in converting between forms of energy," Johnson said. "Obtaining low thermal conductivity in a thermoelectric material, which converts temperature gradients into electrical energy, increases efficiency."

The properties of Johnson's material were measured in Cahill's Illinois laboratory. The structure was analyzed at the APS. Computational simulations and molecular modeling of the layered crystals was carried out by researchers at Rensselaer Polytechnic Institute (RPI) in Troy, N.Y.

Submitted by DOE's Argonne National Laboratory

SRNL's Garrett excels in remote sensing

Alfred Garrett

When Dr. Alfred Garrett was a student of meteorology at MIT, he never really predicted that his career would take some of the twists that it has. Still, he says, the wide range of experiences has strengthened his abilities and given him a variety of opportunities.

Today, the researcher at DOE's Savannah River National Laboratory is a nationally recognized remote thermal IR expert. Washington Savannah River Company, which operates the Savannah River Site and its National Laboratory for DOE, honored him for the way he makes use of those opportunities by presenting him with the Don Orth Award of Merit. The Orth Award, named for an internationally known nuclear chemist who retired from SRS in 1992, is SRS' highest honor in engineering and technical leadership.

Dr. Garrett, who earned a Master's degree in Meteorology (MIT) and a PhD in Civil Engineering (University of Texas), has been at SRS since 1979, first joining SRNL as a meteorologist. His experience as manager of the Meteorology Group, combined with his knowledge of fluid dynamics, led to management assignments in the Savannah River Site's reactor safety programs.

When the reactors were shut down, he decided to return to technical laboratory work. The increasingly complex world situation led him to work in remote sensing, where he could make the most beneficial use of his technical background in meteorology, numerical modeling, and reactor operations. He developed a thermal analysis code that is recognized by U.S. federal agencies, universities, and commercial power companies for security, research, and operational assessment. He was also the SRNL lead in its function as the ground truth collections lab for DOE's Multispectral Thermal Imaging (MTI) satellite, which was designed and built by Sandia National Laboratories and Los Alamos National Laboratory.

Dr. Garrett's technical leadership has contributed to the recognition of SRNL as a leader in remote sensing and as a major contributor to national security. He continues to collaborate extensively with other national laboratories, government agencies, and various universities.

Submitted by DOE's Savannah River National Laboratory