DOE Pulse

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Berkeley Lab's John Prausnitz

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Research Highlights . . .

SPEAR3 "breathes" in response to temperature changes

As the sun rises, the SPEAR3 synchrotron facility at SLAC expands. The change is microscopic, but it doesn't escape the SPEAR3 feedback regulation system. The lattice of beam-focusing magnets expands radially with the structure. But the beam stays put, becoming slightly displaced. To stay centered within the magnets, the beam must also expand. An array of monitors tracks the beam's position, and relays information to the feedback system. The signal cycles every six seconds, instructing the radio-frequency to adjust by about half a hertz per cycle. This allows the beam to "breathe" with daily and seasonal changes in temperature.

[Neil Calder, 650/926-8707, neil.calder@slac.stanford.edu]

Crime in small communities targeted

Residents of small communities could be served and protected better because of a communications system being proposed by researchers at DOE's Oak Ridge National Laboratory. The system would help rural law enforcement agencies—many of which still rely on paper-based systems—quickly gather and share information about criminals and criminal activity. A number of ORNL technologies, some of which were originally developed for NASA to gather and distribute scientific data around the world, would be incorporated into an affordable case management system. The NASA system provides a state-of-the-art data management scheme that uses the Internet and emerging information technologies.

[Ron Walli, 865/576-0226, wallira@ornl.gov]

Preparing for climate change

Global warming conversations have shifted from whether climate is changing to how we will deal with the inevitable consequences. A decade-long case study, funded by EPA and NOAA and conducted by DOE's Pacific Northwest National Laboratory, looked at water availability past, present and future in the bountiful but highly-irrigated Yakima River Valley of south-central Washington state. PNNL researchers examined effects from El Nino to forecast what conditions will look like in the dry years ahead. They found the expected losses to agriculture alone in the Yakima Valley will be between $92 million at two degrees centigrade warming and $163 million a year at four degrees—or up to nearly a quarter of total current crop value—unless policymakers and farmers adjust practices.

[Bill Cannon, 509/375-3732, cannon@pnl.gov]

New technology cleans up molding process

Materials researchers at DOE's Pacific Northwest National Laboratory have developed a new method for powder injection molding that could reduce fabrication costs and increase the use of titanium and similar metals in advanced engineering applications. But alloy impurities caused by the current process have limited the use of injection molded titanium components. The PNNL method overcomes these problems with a proprietary binder that is cleanly removed during manufacture and leaves no impurities that can cause degradation in material properties. In addition, components produced by the PNNL process can be tailored for specialized applications, including self-lubricating parts and biomedical implants.

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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).

New microcopy advances biological imaging to nanoscale

Scanning probe microscopes, usually applied to imaging inorganic materials at nano- to microscopic scales, may soon be giving researchers new insights into the biomechanical structures and functions of living organisms—for example, nature's engineering of a butterfly's wing.

Sergei Kalinin, a Eugene P. Wigner Fellow at DOE's Oak Ridge National Laboratory, and Alexei Gruverman, a research professor at North Carolina State University, have obtained images of the structure of a *Vanessa virginiensis* (American Lady) butterfly's wing at approximately 10 nanometer resolution.

Their experiment demonstrates that emerging advances in scanning probe microscopy can be applied to more than hard inorganic materials such as superconductors and semiconductors. Although the images are "a proof of concept" it is a concept that could eventually provide clues to the functionality of complex hierarchical biological systems such as bones, teeth and other biological tissues.

Nevertheless, even the early results provide clues to the complex structure behind the elasticity and relative durability of the splendidly functional butterfly wing.

"Scanning probe microscopy provides unlimited opportunities for understanding material structure, properties, and functionality at all length scales," says Kalinin. "This will pave the way to better and cheaper materials for biological and medical applications."

Kalinin's and Gruverman's work with imaging biological systems has its roots in the development of atomic force microscopy in the 1980s. Now they are using a technique called Atomic Force Acoustic microscopy, AFAM, which uses tiny blasts of sound to probe not only the surface but also the subsurface structures of delicate biological materials, with approximately five nanometer resolution.

"This improved imaging sheds lights on how biological systems work, down to the five-nanometer resolutions, which is comparable to the size of a DNA molecule-about as small as you need for biological materials," says Kalinin. "Biosystems, because they are not ordered like, for instance, crystalline materials, require real-space imaging of local elastic properties and structure. Scanning probe microscopes are a wonderful tool that is suited for exactly this purpose."

"Scanning probe microscopy is a key to the advancement of nanoscience," says Kalinin. "It is a new field and it develops rapidly, so novel methods appear virtually overnight. However, it takes a sustained interdisciplinary effort before true potential of SPM is realized."

Submitted by DOE's Oak Ridge National Laboratory

CHEMICAL PROCESSING R&D BRINGS NATIONAL HONOR TO PRAUSNITZ

John Prausnitz with President Bush at the White House for the 2003 National Medal of Science Awards

John Prausnitz, a chemical engineer with DOE's Lawrence Berkeley National Laboratory, became the 13th scientist at Berkeley Lab to win the coveted National Medal of Science, the nation's highest scientific honor. He received his medal from President George W. Bush at a White House ceremony on March 14, 2005.

Prausnitz was one of eight researchers named to receive the 2003 edition of the National Medal of Science. His citation reads: For development of engineering-oriented molecular thermodynamics.

"I have always, in a sense, been a communicator between chemical engineers and physical chemists," Prausnitz said. "It has been my concern to make chemical processes, such as the separation of raw petroleum into various products, more efficient, safer and more environmentally friendly."

Born in Berlin, Germany, in 1928, Prausnitz became an American citizen in 1944. He joined the UC Berkeley faculty in 1955, the year he obtained his Ph.D. from Princeton University, after earning his bachelor's degree in chemical engineering from Cornell University in 1950. He joined the Berkeley Lab staff in 1978.

Prausnitz is considered one of the principal architects behind the design of modern chemical manufacturing processes. His research dramatically changed how the thermodynamic properties of mixtures required for chemical processing are calculated. As a result, large-scale chemical plants, such as petroleum refineries, and facilities for the manufacture of polymers, plastics and pharmaceuticals, are far more energy-efficient and less polluting.

In addition to his research, Prausnitz has authored or coauthored over 600 publications and three pioneering books used by chemical engineers throughout the world. He has also mentored a generation of engineers and industrialists, including 75 Ph.D. students and 35 post-doctoral fellows.

Submitted by DOE's Lawrence Berkeley National Laboratory