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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

Dirt aged hurriedly, elegantly observed

What could be more exciting than watching the grass grow? Why, observing dirt age in a hurry, according to a team at DOE's Pacific Northwest National Laboratory that can speed soil's natural aging process to sponge up and trap organic contaminants. In nature, dirt is said to age as water-resisting organic compounds accumulate in mineral pores and organic matter of sediments. PNNL is helping the process along by injecting soils with a contaminant dissolved in carbon dioxide in its so-called supercritical form-a fluid that shares properties of liquids and gases. PNNL project leaders believe the supercritical-fluid aging process can simulate decades of contaminant exposure in just a few hours. Such fluids have the strong penetrating ability of a dense gas, making them ideal for carrying contaminant molecules deeply into the microscopic pores and organic components of soil grains.

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

High-tech for first responders

First responders could minimize the risk to themselves and do their jobs more effectively if they were wearing a protective suit proposed by a team led by DOE's Oak Ridge National Laboratory. The Advanced Integrated Responder Ensemble will be made of new materials, will be lightweight and incorporate sensors and a communications system. The suit will provide thermal protection, personal cooling and will detect and counter chemical and biological threats, dramatically increasing a first-responder's capabilities. Partners in the effort include the Georgia Institute of Technology, North Carolina State University and the University of Tennessee.

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Favorite liquid revisited

Water molecules clump much more loosely than previously thought, says a team led by scientists at Stanford Syncrotron Radiation Laboratory, a division of DOE's Stanford Linear Accelerator Center. In liquid water, molecules form short-lived bonds, in patterns that are still poorly understood. Bonding is thought to determine many of water's unique properties—including the ability to sustain the chemistry of a living cell.

In Science magazine's early-publication online edition, the researchers reported that the average number of bonds in liquid water is 2, instead of the widely accepted estimate of 3.5. The results overturn 20 years of research in the physical chemistry of water," says SLAC's Anders Nilsson, the team's leader.

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Laser-based technique measures 'real world' particulate

A research team led by Sandia National Laboratories' Combustion Research Facility has successfully measured "real world" particulate emissions from a vehicle under actual driving conditions. While on-board measurements of gaseous emissions are routine, real-time particulate measurements have been more elusive, yet are essential for validating federal emissions guidelines for vehicle compliance. The team, which involved Artium Technologies, Chevron Oronite, and the National Research Council (NRC) Canada, used laser-induced incandescence technology on board a 2002 Volkswagen Jetta. Current U.S. Environmental Protection Agency vehicle certification procedures use chassis dynamometer tests, which do not replicate grade changes, weather, and other variables encountered under actual driving conditions.

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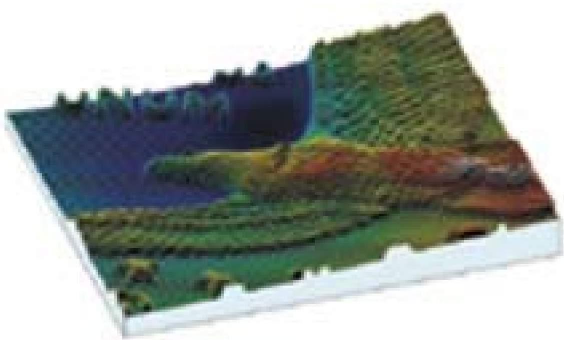
DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions.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

Telltale toolmarks catch crooks

Law enforcement has a new tool to help bring criminals to justice, thanks to research by scientists at the U.S. Department of Energy's Ames Laboratory.

When tools such as screwdrivers, pliers and wire cutters are manufactured, the manufacturing process leaves certain imperfections, or patterns, embedded in the tools' surfaces. These patterns are believed to be unique for each tool, and when criminals use tools to perpetrate crimes, such as jimmying a door to gain access to a location, the patterns on the tools are often transferred to the crime scene.

In the past, investigators have been able to help the courts convict criminals by visually matching the marks on tools to crime scenes. But in a landmark 2000 case, a Florida court deemed a toolmark inadmissible, saying the "proposition of uniqueness" for a knife blade based on marks transferred to a victim was a scientific theory that had been inadequately tested by the scientific community.



Two research projects at the Ames Laboratory have responded to the challenge in an attempt to establish toolmark uniqueness. The first project, spearheaded by Stan Bajic, Ames Laboratory associate scientist, and David Baldwin, director of the Laboratory's Midwest Forensics Resource Center, involved building a database of toolmark images and developing an algorithm to statistically analyze the images. The database consists of digital images of marks on tool surfaces left during six different manufacturing processes.

In a third research project, Scott Chumbley, an Ames Laboratory metallurgist and ISU professor of materials science and engineering, is taking toolmark analysis from the two-dimensional to three-dimensional level.Using a profilometer, a scanning tool that measures the height or depth of toolmarks, and a type of contour map of the marks is developed from the scan. The map can then be used to precisely identify a toolmark, allowing forensic specialists to match the mark on the tool to the marks made by the tool at the crime scene.

Submitted by DOE's Ames Laboratory

JLab nuclear theorist offers 3-D perspective

Anatoly Radyushkin

When Anatoly Radyushkin left Russia to come to DOE's Jefferson Lab in 1992, he was looking to move closer to the action. Despite being a theoretical physicist, he wanted to work in the hustle and bustle of experimentation. But moving to an experimental facility allowed Radyushkin to jump into the fray, leading him to develop the theory of Generalized Parton Distributions, or GPD's, to match experimental data physicists were mulling over just down the hall. These mathematical functions are allowing physicists to, for the first time, obtain a 3-dimensional snapshot of the inner structure of the particles that make up the nucleus of the atom.

"I was lucky to be at the very beginning of this stuff; and that's because I was here. You can do these GPD's anywhere, but to talk to experimentalists, you have to come here, because nowhere else do you have this advantage of direct contact."

For his work on GPD's, Radyushkin's adopted home state has awarded him its highest honor, naming him a Virginia Outstanding Scientist of 2004. The award recognizes scientists who have made a recent contribution to basic scientific research that extends the boundaries of a field of science.

"The first time I came to Virginia, I spent three or four days here in the middle of July. Though I am from a south region of the former Soviet Union where the local population speaks a Turkish-type language, that was my first experience at Turkish Baths, when you open your door and you have all this steam in your face."

Radyushkin is a jointly appointed professor of physics at Old Dominion University and a senior staff scientist at JLab. He is also a permanent staff member of the Laboratory of Theoretical Physics in Dubna, Russia.

Submitted by DOE's Jefferson Lab