DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Charles Taylor

Page 2

Research Highlights . . .

Ames Lab opens magnetoelectronics lab

A new research facility at DOE's Ames Laboratory will help scientists create and, perhaps more importantly, duplicate thin films with unprecedented control. That ability to control a number of variables will allow thin-film "recipes" to be developed and compared, resulting in a much better understanding of how thin-films work. Potential uses of thin-films include nonvolatile computer random access memory (commonly known as RAM) that would require no "boot-up" sequence and would not lose data in cases of power interruptions. The lab was funded by a $530,000 grant from the Roy J. Carver Charitable Trust.

[Kerry Gibson, 515/294-1405, kgibson@ameslab.gov]

Earth: More complicated than we thought

The chemical ingredients at the center of Earth are surprisingly complicated, according to high-temperature, high-pressure experiments conducted at DOE's Argonne National Laboratory. University of Chicago scientists used Argonne's Advanced Photon Source to find experimental evidence suggesting that the Earth's inner core largely consists of two exotic forms of iron, alloyed with silicon, instead of only one. The Chicago research team simulated searing subsurface temperatures of approximately 4,200 degrees Fahrenheit and crushing pressures of 840,000 atmospheres with a laser-heated diamond anvil cell. They found the atomic structure of iron changes under conditions found at 1,800 miles beneath Earth's surface.

[Catherine Foster, 630/252-5580 or cfoster@anl.gov]

Fermilab researchers begin recording 'physics-quality data'

Researchers at CDF and DZero, the 5,000-ton particle detectors at DOE's Fermilab, have begun recording what they call "physics-quality data" from particle collision events in Collider Run II of the Tevatron. Says CDF cospokesperson Al Goshaw, of Duke University: "For many analyses, the data we are taking could appear in future publications." The heightened activity also emphasizes the diversity and international nature of researchers at the lab. "It is wonderful to see people on shift excited about our data-taking," he continues, "and working across language, gender and age boundaries to keep the detector running efficiently."

[Mike Perricone, 630/840-3351 mikep@fnal.gov]

New material gets bigger when squeezed

Most materials get compacted or fall apart under pressure. But scientists working at DOE's Brookhaven Lab have discovered a zeolite that expands when squeezed. Structural studies at the National Synchrotron Light Source at Brookhaven reveal that it's possible to squeeze extra fluid into tiny pores in the material, thereby increasing its volume. The scientists say this material might be useful as a "molecular sponge" for soaking up chemical pollutants or even radioactive waste because, when the pressure is released and the material contracts, the fluid—potentially a pollutant—would be trapped inside. Studies will continue to see if this approach will work.

[Karen McNulty Walsh, 631/344-8350, kmcnulty@bnl.gov]

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).

It's warm. It's dense. It *really* matters

It's the hinterland of science, where uncertainties prevail. It's a place where we seek equations of state, but where systems are not always in equilibrium. It's the unpredictable transition that all materials pass through in the flux between solid state and plasma. It's a regime where "a shock is a shock, is a shock," but where the results may vary with the source of the shock. It's most definitely a new research frontier-and it may be a grand challenge!

Sound confusing? Some researchers at DOE's Lawrence Livermore National Laboratory thought so and organized the first annual workshop on extreme states of materials to study a phenomenon called "warm dense matter," a term that actually originated at Livermore.

The Livermore Materials Research Institute organized this unclassified workshop, held off site February 20-22. Collaborators came from other DOE labs, like Lawrence Berkeley, and from as far away as Germany.

According to co-chair Mike McElfresh, director of Livermore, organizers wanted to define the role that the labs will play in the rapidly emerging area of warm dense matter research, and in understanding its importance to stockpile stewardship. Work in the warm dense matter regime has ramped up over the past two years. It was time to bring all these researcher together, to compare notes and stimulate the theoretical community. We wanted to determine where we're going next, and develop a plan to get there, McElfresh explained.

The workshop focused the joint efforts by examining present and future research using drivers such as the current synchrotron and future FEL-based light sources, energetic materials (like high explosives), ion-beams, lasers, diamond-anvil cells and mechanical impact techniques. Participants reviewed current experimental and theoretical tools covering the relevant pressure, temperature, and density-phase space accessible by each method.

What researchers learn in the future in this area will have practical applications in stockpile stewardship, geophysics, inertial confinement fusion, ICF target design, and the astrophysics of cooler stars and bigger planets. The answers we uncover can help us understand what lies within the center of planets, and explain magnetic fields around Jupiter.

The workshop also attempted to evaluate the future role of the National Ignition Facility research in the warm dense matter regime. NIF experiments in this area can begin as soon as NIF's first four-beam quad becomes operational.

McElfresh emphasized the Livermore Lab's history of pushing the frontiers of materials at extreme conditions, and addressing highly relevant areas. To promote research in warm dense matter and focus it on scientific issues, annual workshops are planned, and a working group is being formed. Researchers interested in participating should call him at 925/422-8686 or send e-mail to <mcelfresh1@llnl.gov>.

Submitted by DOE's Lawrence Livermore National Laboratory

NETL SCIENTIST DISCOVERS SURPRISING METHANE-CONVERSION PROCESS

Charles Taylor

After 17 years on the same job, it's hard for most people to still be excited about coming to work. But then Charles Taylor, a physical scientist at DOE's National Energy Technology Laboratory, isn't most people.

He was elected secretary of the American Chemical Society's Division of Fuels Chemistry, and discovered that a photocatalyst, which uses sunlight, can convert methane in a methane hydrate molecule into methanol and hydrogen. All within the last year.

The methane-conversion process is big news, attracting "a lot of attention now and in the next year," Taylor said. "Everyone thought the methane molecule was relatively inert (unreactive)." In fact, it is the subject of many up and coming presentations and symposiums.

This is right in Taylor's bailiwick. He spends his days working on methane conversion as a means of producing cleaner gasoline and diesel fuels as well as hydrogen for fuel cells. Technologically, several processes are very successful, he said, but they are unable to compete with the price of oil, which is less than $20 a barrel. Even if foreign oil prices rise, the fuel cell market remains a victim of the chicken-and-the-egg battle. "Automotive manufacturers say they cannot produce fuel cell vehicles until a distribution system is set up," Taylor noted. "And distributors say there is no need for a system without fuel cell cars."

Although pipelines and gas stations are ready to dispense cleaner gasoline and even hydrogen, which is a gaseous fuel, Taylor acknowledges that a pre-cleaning step at the very least would be necessary to remove decades of sulfur that coats pipelines, and would most likely contaminate any clean-burning fuel.

But the controversy hasn't stopped him from inventing five methane-conversion processes, all of which have been patented. And in the last four years he has emerged as a team leader, accepting more oversight duties at NETL's Ultra-Clean Fuels Division.

Submitted by DOE's National Energy Technology Laboratory