LANL researcher studies the “bystander effect”

Page 2

DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

Chemistry aids storage

Storage of the nation’s excess actinide metals, including plutonium and uranium, present a myriad of problems from pollution concerns to proliferation risk. Solid-state chemists at DOE’s Los Alamos National Laboratory have discovered a new reaction process that may prove to be a solution to some of the storage problems. The scientists have been looking at methods of reacting actinide elements with stable elements. The goal is the creation of uranium, thorium and plutonium compounds that are more environmentally friendly and harder to reconstitute for use in weapons.

[Kay Roybal, 505/665-0582, k_roybal@lanl.gov]

“Experiments in a drum” save millions

An expendable steel vessel, slightly larger than an oil drum, allows researchers at DOE’s Lawrence Livermore National Laboratory to collect subcritical-experiment data better, faster—and a *whole lot cheaper*. Subcritical explosive tests, deep beneath the Nevada desert, provide important data for watching over the nation’s nuclear weapon stockpile. These vessels completely confine subcritical experiments, making it unnecessary to excavate a subterranean alcove for each one. Doing so saves about $5 million/year in mining and construction costs, and doubles the lifetime of the underground experimental complex. Diagnostic data is recorded inside or outside the alcove, depending on the experiment’s requirements.

[David Schwoegler, 925/422-6900, newsguy@llnl.gov]

Single RNA molecules folded, refolded

Researchers with DOE’s Lawrence Berkeley National Laboratory have for the first time successfully unfolded and refolded single molecules of ribonucleic acid or RNA, the molecular family that transcribes the coded instructions of DNA and assembles amino acids into proteins. By applying stretching forces to molecules featuring one of three representative RNA substructures, the researchers were able to observe the molecules unfold as they would in a living cell and measure the energy required to drive the folding reaction. These experiments and their results hold importance for, among other applications, the future design of antiviral and other therapeutic drugs.

[Lynn Yarris, 510/486-5375, lcyarris@lbl.gov]

TRIPS prevents tripping through red tape

Shipping nuclear waste produces monumental amounts of paper. Now, a new digital signature technology at DOE’s Idaho National Engineering and Environmental Laboratory permits secure electronic waste management, eliminating the paperwork while ensuring the integrity of the electronic data. The Transuranic Reporting, Inventory and Processing System (TRIPS) gathers and presents as an electronic form information about the waste to be shipped. After users digitally “sign” the form, the system verifies the signature, remembers exactly what the user signed and any subsequent changes. Unlike commercial digital signatures, the INEEL signature signs data in hundreds of databases. TRIPS is expected to save around 900,000 pieces of paper yearly.

[Kathy Gatens, 208/526-1058, kzc@inel.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).

Labs tackle semiconductor barrier

Scientists at DOE's Oak Ridge and Pacific Northwest national laboratories and Motorola Labs are working together to increase the speed of future generations of integrated circuits.

The scientists, working under a cooperative R&D agreement, will pursue new materials that they believe may overcome a fundamental physics problem that threatens to limit future semiconductor improvements, and for which the semiconductor industry currently has no solution.

For decades, the semiconductor industry has been able to continue increasing the amount of circuitry, or computing power, on a chip while reducing its size—enabling smaller, faster and better electronic products. However, researchers have long known that the industry will eventually hit a wall that will prevent semiconductor designers from achieving additional size reduction.

The problem lies with the current gate insulating material, a layer of silicon the thickness of 25 individual silicon atoms. The silicon dioxide layer "gates" the electrons, controlling the flow of electricity across the transistor. Each time the chip is reduced in size, the silicon dioxide layer must also be proportionally thinned. Unfortunately, the thickness will soon (anticipated later next year), have to be reduced to a point where the silicon dioxide is no longer able to provide effective insulation.

Most industry experts predict the need to develop new materials with a higher dielectric constants (sometimes referred to as high-k materials) that have a higher capacitance for a given thickness. Independent of each other, ORNL and Motorola Labs have been developing just such materials in the form of crystalline oxides on silicon and other semiconductor materials.

"By using crystalline oxides, we're able to eliminate one of the hurdles to continuing the current rate of growth in the semiconductor industry," said ORNL's Rodney McKee. The work of McKee and colleague Fred Walker addresses the transistor gate—the dielectric layer that controls the flow of electricity through the transistor.

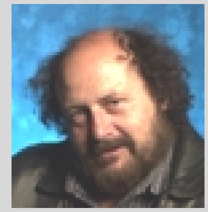
Motorola Labs also has been researching high-k materials for several years and, in 1999, demonstrated the world's thinnest functional transistor by growing a strontium titanate crystalline material on a silicon substrate. This high-k material demonstrated electrical properties more than 10 times better than equivalent silicon dioxide.

While both labs have made significant progress independently, the scientists hope that combining their expertise will enable them to solve more quickly the remaining issues for the benefit of the entire U.S. semiconductor industry.

"Both ORNL and Motorola Labs have made promising progress in the past few years, and we are looking forward to evaluating the specifics of ORNL's technology," said Bill Ooms, of Motorola Labs. "Motorola Labs has already been working with PNNL to evaluate the samples grown at Motorola, and they will bring to the project an important expertise in understanding the growth mechanism and structural and electronic properties of the semiconductor-oxide interface."

Submitted by DOE's Oak Ridge National Laboratory

Bruce Lehnert studies the "bystander effect"



Bruce Lehnert

A biologist at DOE's Los Alamos National Laboratory has contributed to an important discovery about the effects of low - level radiation on cells that may alter long-held beliefs about risk assessment in radiation exposure. Bruce Lehnert 's study of the effects of fluid-phase mediators from irradiated human cells on non-irradiated cells has confirmed the existence of the so-called "bystander effect." The effect induces a response that could hold the key to the causes of genomic instability underlying carcinogenesis.

"We are studying cancer mechanisms at their most basic level, looking for pathways that may underlie genomic instability," Lehnert said. "Finding those pathways may show us how we can deal therapeutically with the health effects of radiation exposure."

DOE has long been interested in individualized risk assessment for radiation exposure. Scientists are seeking to identify genes that play crucial roles in determining an individual's susceptibility to the effects of ionizing radiation and are looking for the mechanism that causes genes to become unstable.

Lehnert holds a Ph.D in toxicology from the University of Rochester. When he first came to Los Alamos nearly 20 years ago, he worked on the effects of toxic gases on the lungs. His experiments demonstrated that exercise exacerbates the effects of toxic gases in the lungs, which has important implications for soldiers exposed in the field.

On the lookout for interesting problems in radiation biology, Lehnert was intrigued by papers on genomic instability that suggested a far-reaching phenomenon activates something in cells making them susceptible to damage. Definitively demonstrating that radiation can produce bystander effects on neighboring cells has introduced a new variable in risk assessment.

"The bystander effect may or may not contribute to cancer, as yet we simply don't know its health implications," Lehnert said. "Understanding it, however, will change how we do risk assessment."

Submitted by DOE's Los Alamos National Laboratory