DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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*Argonne's John Arrington with Dr. Raymond Orbach*

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# Research Highlights . . .

## Green chemistry removes uranium from metal surfaces

Scientists from DOE's Brookhaven National Laboratory and Stony Brook University have developed a simple, safe, "green" method of removing uranium from contaminated metal surfaces. The environmentally friendly process uses all naturally occurring materials — citric acid, common soil bacteria, and sunlight. Wastewater generated during decontamination undergoes biodegradation followed by photodegradation, minimizing the generation of secondary waste and allowing the uranium to be removed. The cleaned materials can then be recycled or disposed of as low-level radioactive or nonradioactive waste.

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## Strange quarks influence the proton

In research performed at DOE's Jefferson Lab, evidence suggests that strange quarks contribute to proton structure. In addition to the proton's three resident quarks, consisting of up and down quarks, quantum mechanics allows other particles to appear from time to time. These ghostly particles usually vanish in a tiny fraction of a second, but nuclear physicists found that some of these particles, strange quarks, hang around long enough to influence proton structure by modifying its electric charge and magnetization. The result comes from work performed by the G-Zero collaboration, an international group of 108 physicists from 19 institutions.

***[Kandice Carter, 757/269-7263, kcarter@jlab.org]***

## "Tall" crystals

DOE's Ames Laboratory researchers have achieved a first in the world of novel optical materials, modifying an old technique known as microtransfer molding to create multilevel photonic crystals at micron- and submicron-length scales. Their ability to construct photonic crystals four millimeters square (approximately one-eighth of an inch square) and 12 layers high in the open air, without benefit of a "clean-room" environment or the multimillion dollar equipment traditionally required to create such structures, is testimony to the success of the modified technique, *although multi-domains exist in each crystal and alignment remains a challenge*. The fundamental research holds potential for significantly reducing the costs associated with fabricating photonic crystals.

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## Frictionless carbon coatings get tryout

DOE's Argonne National Laboratory and the Kurt J. Lesker Company will study the durability of nearly frictionless carbon coatings in high-performance environments. The R&D 100 award-winning coating, developed at Argonne, has a lower coefficient of friction than any other material. The nine-month collaboration will examine the coating as a replacement for chemical lubricants used in neutron choppers, high-speed disks that operate in a vacuum. Chemical lubricants degrade rapidly in the vacuum, limiting the operating speed of the neutron choppers and reducing the accuracy of neutron beam measurements. The cooperative research and development agreement is funded by a Phase I grant of the DOE Small Business Technology Transfer Program.

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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 analytical tool helps detect cancer

Scientists have long used ultra-fine glass tubes known as capillaries to analyze the chemical makeup of substances. Called capillary electrophoresis, or CE, the method applies high voltage to the capillaries, and by measuring the rate that the various materials move through the capillaries, researchers are able to identify each compound.

A group of researchers at DOE's Ames Laboratory has developed a method called dynamic multiple equilibrium gradients, DMEG for short, that dramatically fine-tunes the process, allowing for a significant increase in resolution over previous methods. Potential applications include chemical, biological and biomedical sciences, as well as in environmental monitoring, biological warfare detection, drug discovery, and more, can be envisioned.

"This method is hyperselective and we can design it to target specific analytes for separation," said Ryszard Jankowiak, Ames Lab senior scientist. "Running multiple electric field gradients can focus and move the analytes to the detection window at precisely defined times, creating signature 'fingerprints,' which minimizes the probability of false positives."

The advance makes it possible to detect the smallest traces of substances, such as the estrogen-derived conjugates and DNA adducts in human fluid samples that could serve as biomarkers in risk assessment of breast and prostate cancers. In fact, this and other technologies being developed at the Ames Laboratory—biosensors and fluorescence-based imaging—have been used in work with cancer researchers at the University of Nebraska Medical Center and Johns Hopkins University to identify a specific adduct in the urine of prostate and breast cancer patients, and could lead to even earlier detection or indication of cancer risk.

Unlike traditional capillary electrophoresis, Jankowiak,s team, which includes Yuri Markushin and graduate student Abdulilah Dawoud, uses only low voltage, around 2kV or less. Another difference is in the way the voltage is applied. Tiny electrodes are microfabricated along the walls of the hair-like capillaries (or channels), in essence creating a complex grid of electrodes.

Because the system can be fine-tuned to separate specific substances and concentrate them at particular points as they move through the capillaries, it can be used to create crystals. One potential application for this new crystal growth method is photosynthetic complexes for use in solar/photovoltaic cells  Another possible application is for desalinization of seawater, using DMEG to extract the salt. Just recently, Jankowiak has been awarded a grant by ONR/NASA to pursue research in this area.

***Submitted by DOE's Ames Laboratory***

## Argonne's Arrington wins with Jefferson Lab-based research

***John Arrington receives the award from The Director of the Department of Energy's Office of Science, Dr. Raymond L. Orbach.***

Just back from a meeting in Italy, John Arrington was anxious to catch up on his e-mail before a lunchtime volleyball game. An Argonne National Laboratory physicist, Arrington has been busy since receiving the Presidential Early Career Award for Scientists and Engineers in mid-June, recognizing his contribution to the advancement of science through research into quark distributions in nuclei.

The research, performed at DOE's Jefferson Lab, was a combination of his thesis work as a Caltech graduate student, Jefferson Lab experiments in 2004 he collaborated on, and future plans.

Arrington says he's happy his research has received attention, "It's always great to receive recognition for your work," and he adds, "It will certainly help over the next couple of years, because it comes with a certain amount of money for research."

Arrington studies how the nucleus is built of quarks and gluons. "We have a very clear picture that quarks are in the protons and neutrons [nucleons]. But when you build a nucleus, you never see the quarks, you just see protons and neutrons and how they interact, just because the quarks are bound up so tightly. But there are regions where the nucleons interact at high-enough energy where you can see the effects of the quarks in nuclei."

The Presidential Awards recognize some of the finest scientists and engineers who, while early in their research careers, show exceptional potential for leadership at the frontiers of scientific knowledge. The Awards support the continued development of the awardees, foster innovative and far-reaching developments in science and technology, increase awareness of careers in science and engineering, give recognition to the scientific missions of participating agencies, enhance connections between fundamental research and national goals, and highlight the importance of science and technology for the nation's future.

***Submitted by DOE's Jefferson Lab***