*Complexity lures INEEL's Stoner,*

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# Research Highlights . . .

DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

Number 81 May 21, 2001

## Buckybowls by the bucketful

Scientists may be closer to unlocking the mystery of buckyballs, curious hollow spheres formed by 60 atoms of carbon, thanks to research being conducted by Peter Rabideau, a senior chemist at the DOE's Ames Laboratory. Using simple solution chemistry, Rabideau has developed a process to produce gram quantities of corannulene ($C_{20}H_{10}$), a curved-surface, aromatic hydrocarbon. Nicknamed buckybowls, the bowl-shaped corannulene molecules represent the "polar cap" of the $C_{60}$ sphere. By making it possible to produce large quantities of these bowl segments, Rabideau hopes to eventually piece together a complete buckyball.

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

## Fermilab makes Nu's

Since neutrinos barely interact with matter, scientists increase the likelihood of observing one of these elusive particles by building extremely massive detectors. When their experiment begins operating next year, the scientists of the MiniBooNE experiment at DOE's Fermilab will use a 12-meter diameter sphere filled with one million liters of mineral oil in which the rare collision of a neutrino with a nucleus creates a tiny light flash. Inside the tank, more than 1,000 light-sensitive devices, called photomultipliers, will record the flashes and transmit electrical signals to the data acquisition system. Researchers are now completing installation of the PMTs for MiniBooNE.

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## Insight into antibiotic resistance

A detailed picture of how the ribosome allows accurate translation of the genetic code has been obtained by a team of British biologists using the Advanced Photon Source at DOE's Argonne National Laboratory. The ribosome is the molecular machine in all cells that makes proteins by translating the information encoded by genes. Dr. Venki Ramakrishnan, head of the Medical Research Council Laboratory of Molecular Biology, explained: "Pharmaceutical and biotech companies are keenly interested because this research not only helps us to understand how antibiotics work but also helps us to design new antibiotics in the future that can overcome the growing world-wide problem of resistance."

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## New way to make metal oxides

Scientists at DOE's Brookhaven National Laboratory have devised a novel way of making metal oxides. This class of compounds is commonly used in catalysts and cosmetics, and is important to the growing field of nanotechnology. The new method allows greater control of the particle size and chemical composition of the product, and avoids the dangers and difficulties of working with molten liquid metal. Instead, the Brookhaven scientists combine the metal with graphite and heat it to form an intermediate compound, a metal carbide. Then the scientists apply more heat to decompose the metal carbide. The metal gets released as a vapor, which can be oxidized to form pure metal oxide powder.

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# Unlocking manure's potential

It's hard to think of animal manure as a valuable commodity. But with 160 million tons of it produced annually in the United States, and most of it rich in carbohydrates and proteins, researchers at DOE's Pacific Northwest National Laboratory and Washington State University see potential in converting substantial portions of it to commodity chemicals and other high-value products.

PNNL and WSU are beginning a two-year study to determine the best processes to generate higher-value products from manure. The study is being funded by an $800,000 grant through DOE's Office of Energy Efficiency and Renewable Energy.

The team will use the carbohydrate- and protein-based chemical building blocks from manure to produce a range of products. The carbohydrate material composed of five- and six-carbon sugars will be converted to commodity chemicals, such as glycols or diols, commonly used to manufacture antifreeze or certain plastics. The protein components will be converted to animal feed and other products.

PNNL has developed innovative catalytic approaches for converting other low-value biobased materials to chemicals, such as the wastes and by-products resulting from processing corn, wheat, potatoes and dairy products. PNNL researchers separate the carbohydrates, proteins and oils from low-value feedstocks and then catalytically convert those to higher-value products. This approach will be applied to manure, described as a messier resource by Dr. Don Stevens, project manager for the PNNL work.

"While some biomass feedstocks, such as wheat wastes, are mostly made up of clean carbohydrates, manure is messier with only about half of it consisting of carbohydrates. Additionally, manure contains a much higher protein percentage and a greater mix of minerals," said Stevens. The production of chemicals is, therefore, more complex and the processes include more extensive separations of these components to be useful for chemical production, he said.

PNNL is teaming with WSU researchers because of their extensive experience in separations chemistry and in recovery of high-value protein products. WSU is a land-grant university and operates dairies and feedlots in Pullman and Puyallup, Washington.

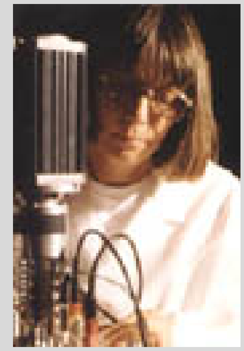
The payoff could be huge—environmentally and economically. "Animal waste is increasingly difficult to dispose of. With fewer, but larger, animal operations across the U.S., the waste is more geographically concentrated, resulting in more environmental problems," Stevens said.

"By successfully converting the wastes into chemicals, we can greatly reduce the need for open-field disposal of manure, which will reduce odor problems, methane emission to the atmosphere, and run-off of contaminants into streams and lakes."

Another payoff is reducing the number of petroleum-based products on the market. Currently, almost all the medium-volume commodity chemicals, such as those used to make antifreeze, carpet fibers and soda pop bottles, are petroleum-derived.

***Submitted by DOE's Pacific Northwest National Laboratory***

# Confronting Complexity in a Complicated World



***Daphne Stoner***

Simply put, microbiologist Daphne Stoner is drawn to "complexity." The only complication this has caused the 14-year veteran of DOE's Idaho National Engineering and Environmental Laboratory is the inherent difficulty in simplifying complex systems.

"Things that are complicated aren't necessarily complex," she says. "If something's complicated, you can understand the whole system by studying each of the components. But with a complex system, understanding the separate parts doesn't mean you'll understand the whole."

Hardly a reductionist, Stoner knows that complex systems must be dealt with on their own terms. At the INEEL, she helped develop an intelligent control system that optimizes and controls the dynamic bioprocess of microbial growth—like creating an ecosystem in a bottle.

Stoner understands that a microbiologist can't study the complex world alone, routinely assembling interdisciplinary groups to help her tackle scientific problems. She also looks for new ways to think about old problems with an ad hoc discussion group of computer scientists, microbiologists, engineers and chemists culled from the INEEL labs.

"People tend to compartmentalize their lives. Microbiologists talk to microbiologists, geologists talk to geologists," she says. "Life isn't that simple. Neither are scientific problems."

Currently, Stoner is working with a similarly diverse group of INEEL researchers on a method to turn images into numbers. The researchers want to mathematically describe qualitative, visual data such as biological growth patterns or images of subsurface contamination.

"You can't put a picture into a formula for a control system," says Stoner. "Right now there are only words to describe the appearance of biofilms or land patterns. We want to change that."

***Submitted by DOE's Idaho National Engineering and Environmental Laboratory***