NREL's Mark Winlass

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DOE Pulse

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Research Highlights . . .

New polymer becomes wetter as temperature increases

Berkeley Lab scientists have developed a polymer membrane that becomes wetter as the temperature of the surrounding air increases. The one-of-a-kind material, as unlikely as clothes that come out of the dryer wetter than when they went in, has the potential to increase the efficiency of polymer electrolyte fuel cells, which are being developed as a non-polluting way to power cars and other applications. The polymer sponges up more moisture from its immediate environment as the temperature rises and the relative humidity remains constant. With this unique property, it could overcome a limitation common to polymer electrolyte fuel cells, which lose water as the temperature increases, and subsequently suffer a decrease in proton conductivity. Full story.

[Dan Krotz, 510/486-6641, dakrotz@lbl.gov]

NETL completes virtual plant simulation collaboration

A three-year collaboration between DOE's National Energy Technology Laboratory and the United Kingdom has led to the development of compatible virtual power plant/equipment co-simulation software platforms. The collaboration took advantage of synergies between NETL's Advanced Process Engineering Co-Simulator (APECS) project and the U.K. Virtual Plant Demonstration Model (VPDM) project, as well as the CAPE-OPEN Laboratories Network. The APECS and VPDM projects exploited the process industry CAPE-OPEN software standard to provide plug-and-play interoperability between power plant simulation and high-fidelity computational fluid dynamics models of key equipment items such as gasifiers, gas turbines, heat recovery steam generators, and fuel cells.

[Linda Morton, 304/285-4543, Linda.morton@netl.doe.gov]

Virus detection system cuts sample size by million

Researchers have developed a new system that can detect viruses in sample amounts one million times smaller than current commercial instruments and with about half of the analysis steps. This advance, achieved by a team of scientists and engineers from DOE's Lawrence Livermore National Laboratory and University of California, Davis, will lead to more rapid detection of viruses and other pathogens. The research is described in the Nov. 15 cover story of *Analytical Chemistry*." The advantage of reducing the volume size of the sample is that the fluorescent signal can be seen sooner than in commercial devices because it becomes so much brighter," said Bill Colston, one of the paper's authors.

[Steve Wampler 925/423-3107 wampler1@llnl.gov]

LANL looks forward to Roadrunner

DOE's Los Alamos National Laboratory has decided to pursue, pending approval by the NNSA, the final phase of Roadrunner, a high-performance computer slated to become the computational cornerstone of Laboratory mission-related work. Roadrunner is designed to sustain an operating speed of 1,000 trillion calculations each second, or roughly three times faster than the fastest current supercomputer. Los Alamos and IBM have been developing Roadrunner since early 2006. The full-scale Roadrunner machine will operate more than 10 times faster on real applications than the current installed proof-of-concept system, operating at 71-teraflop/s. The first computing applications are expected to begin running on the full-scale Roadrunner in January 2009.

[James Rickman, 505/665-9203 elvis@lanl.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).

NETL researchers develop new material for CO_2 adsorption

Researchers at DOE's National Energy Technology Laboratory (NETL) are always seeking answers in their quest to safely and economically capture greenhouse gases. The development of a new material for the adsorption of carbon dioxide (CO_2) has taken them one step further toward this goal.

The new adsorbent, developed by NETL researcher Jeff Culp, is a unique member of the latest class of materials called metal organic frameworks (MOFs) and is a flexible pillared-layered compound. The pillars are a specially chosen organic compound and the layers consist of sheets of nickel cyanide. Together they are inter-layered to create a series of open channels that can accommodate gas molecules. When CO_2 is not present, the pillars are tilted and the structure is partially collapsed; however, as CO_2 is adsorbed into the structure, the pillars "stand at attention," the channels open up, and more gas molecules are captured.

"Culp with MOF" NETL's Jeff Culp with an MOF

The behavior of the MOF is very unusual in that it displays dramatic structural changes when exposed to varying degrees of pressure. Most adsorbents used to capture gases are rigid; they simply fill with increasing pressure and empty with decreasing pressure. When the MOF is filled with CO_2, a certain threshold pressure is required to force the structure open. Pressure can be released once the structure is full, yet it retains the CO_2 until pressure levels are minimal. Unlike rigid structures, the adsorbent then returns to its previous relaxed state.

The flexible nature of the structure depends on the exact structure of the pillar, which can be controlled by NETL researchers. Brad Bockrath, a physical scientist with the Chemistry and Surface Science Division, points out that this degree of control is a great advance in adsorption science and "opens up new doors for novel materials that will improve the capture or separation of carbon dioxide." Publication of the findings is expected early next year.

Submitted by DOE's National Energy Technology Laboratory

NREL's Wanlass seeks to create a better solar cell

Mark Wanlass

Mark Wanlass' twist on the design of multi-layered solar cells created a new type of device capable of out performing all others in efficiency.

By using several layers of semiconductor, multi-junction solar cells are capable of record-breaking efficiency in converting sunlight to electricity and maintaining a high efficiency under great concentrations of solar energy. Wanlass, a researcher at DOE's National Renewable Energy Laboratory, has been working on multi-junction solar cells since 1980.

Conventional multi-junction cells are grown from the bottom up, starting with germanium and transitioning to silicon for the top layers, leaving the cell bound to the thick, heavy germanium substrate it grew out of. Wanlass suggested the cell be grown upside down so the germanium substrate can be removed, reducing thickness, weight and cost.

Wanlass' design also incorporates lattice-mismatched materials, which he developed extensively while researching thermophotovoltaic (electricity directly from heat) technology for nearly 15 years. Typically the atoms in a multi-junction cell are evenly spaced, which generally results in superior electrical performance. But with mismatched materials, the atoms are unevenly spaced, giving designers more materials to choose from to create even higher-efficiency solar cells. The overall result is a better multi-junction solar cell with higher performance.

"The inverted multi-junction solar is really the crown jewel of my career," Wanlass said. "It is very rewarding to have had a hand in something that is having an actual impact on the commercial side of solar."

Wanlass has spent his career looking to create a better solar cell. After earning his bachelor¹s degree at Cornell University in 1979, Wanlass began working as a full-time researcher at NREL. Since then, he has earned his masters in physics from the Colorado School of Mines and his doctorate from the University of Wales.

"I was in it for the long haul," he said.

Submitted by DOE's National Renewable Energy Laboratory