JLab's Arne Freyberger

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DOE Pulse

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Research Highlights . . .

NETL researchers study novel approach to CO_2 removal

NETL researchers are addressing the challenges standing in the way of a novel energy production method—chemical looping combustion (CLC)—that produces sequestration-ready carbon dioxide (CO_2). In CLC, an oxygen carrier is prepared by first oxidizing a metal with air. The hot metal oxide is then reduced in contact with a fuel in a second reactor, thus combusting the fuel and producing CO_2 and water. The researchers demonstrated the feasibility of utilizing oxygen carriers for coal combustion by heating samples of coal mixed with oxides of copper, nickel and manganese in the presence of CO_2. The coal was fully combusted.

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

Better farming could avert Gulf dead zone

Improved management of crops and perennials could go a long way toward alleviating the problem of hypoxia, which claims thousands of fish, shrimp and shellfish in the Gulf of Mexico each spring. An assessment by a team from DOE's Oak Ridge National Laboratory concludes that low oxygen levels in water, or hypoxia, causes problems throughout the ecosystem. The death zone, scientifically documented in the Gulf since 1985, has consistently covered about 6,000 square miles, usually off the coast of Louisiana west of the Mississippi River's mouth. The problem is caused in part by fertilizer run-off from agricultural activities in the Mississippi basin. These nutrients encourage algae growth. The algae, then dies and sinks to the bottom, where it decomposes, using up oxygen in the process.

[Ron Walli, 865/576-0226, wallra@ornl.gov]

LLNL postdoc's theory on molecular dynamics materializes

Raymond Friddle, a postdoc at Lawrence Livermore National Laboratory has come up with a complete theory to model how force can assist a molecule to change from one configuration to another. Friddle describes the first complete theory that is valid in general cases of forcing a molecule to switch states. The structure of molecular-scale objects is not fixed, but instead is constantly shaken up by the vibrations of thermal energy. Given enough time, a small object will spontaneously switch from one design to another, with each switch occurring randomly. The research appears in the April 4 issue of *Physical Review Letters*.

[Anne Stark, 925/422-9799, Stark8@llnl.gov]

Collaboration to explore revolutionary solar energy conversion

The newest research center of the Colorado Renewable Energy Collaboratory aims to find ways to directly convert the sun's energy to low-cost electricity and fuels. The Center for Revolutionary Solar Photoconversion (CRSP) will be dedicated to basic and applied research at the Collaboratory's four member institutions, DOE's National Renewable Energy Laboratory (NREL), the Colorado School of Mines, Colorado State University and the University of Colorado at Boulder. Twelve companies also have joined CRSP as founding members. NREL Senior Research Fellow Arthur Nozik will serve as scientific director of CRSP. Initial shared research projects will be selected by CRSP members and funded through membership fees and the Colorado Renewable Energy Authority.

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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).

Quantum computers – "spinning" toward reality

Researchers at DOE's Ames Laboratory; the University of California, Santa Barbara; and Microsoft Station Q are teaming up to learn how quantum mechanical states break down. The scientists have made significant advancements in understanding one of the fundamental problems of quantum mechanics, which is also blocking efforts to develop practical quantum computers: the problem of decoherence. Their respective theoretical and experimental studies investigate how a single microscopic object loses its quantum-mechanical properties through interactions with the environment.

"Quantum-mechanical particles can interact with their environments: visible light, or photons; molecules of the air; crystal vibrations; and many other things," said Viatcheslav Dobrovitski, an Ames Laboratory theoretical physicist. "All these uncontrollable interactions randomly 'kick' the system, destroying quantum phases, or the ability of particles to preserve coherence between different quantum states."

Quantum coherence is essential to developing quantum computers in which information would be stored and processed on quantum mechanical states of quantum bits, called qubits. So the self-destructive nature of quantum-mechanical states interacting with the environment is a huge problem.

To find out more about how quantum coherence breaks down and to study the dynamics of this decoherence process, the Ames Lab, UCSB and Microsoft Station Q team studied certain spin systems called nitrogen-vacancy, N-V, impurity centers in diamond. The researchers were able to manipulate a single N-V center interacting with an environment of nitrogen spins in a piece of diamond. Amazingly, they were able to tune and adjust the environmental interference extremely well, accessing surprisingly different regimes of decoherence in a single system. They showed that the degree of interaction between the qubit and the interfering environment could be regulated by applying a moderate magnetic field. By using analytical theory and advanced computer simulations, the scientists gained a clear qualitative picture of the decoherence process in different regimes, and also provided an excellent quantitative description of the quantum spin dynamics. The experiments were performed at room temperature rather than at the extremely low temperatures often required for most atomic-scale investigations.

This research was selected as the basis for the cover of the April 18, 2008 issue of Science magazine. -- http://www.sciencemag.org/content/vol320/issue5874/cover.dtl.

Submitted by DOE's Ames Laboratory

LIFELONG SURFER GUIDES WAVES FOR ELECTRONS

Arne Freyberger pauses for a moment in the CEBAF control room.

Arne Freyberger remembers, almost to the moment, when he chose physics as his life's work.

"I was always taking things apart as a kid," he recalled. "I was always into radios and electronics." But it was a PBS show on particle physics that really turned his head. "I decided right then that I would make physics my career."

Freyberger was appointed director of operations for the Continuous Electron Beam Accelerator Facility at DOE's Jefferson Lab on Oct. 1, 2007.

The path that brought him to his position started with that inherent interest in physics instilled during his childhood in New Jersey.

After graduating from high school, it was on to Rutgers for his bachelor's degree and then to Carnegie Mellon for his master's and Ph.D. in physics. As a postdoctoral fellow, he worked on the CLEO experiment at Cornell, developing analysis software.

He came to Jefferson Lab in 1994 and worked on all aspects of commissioning the lab's Experimental Hall B. In 2002, he decided to make a change and moved to the Accelerator Division.

"I became more and more involved in understanding the CEBAF machine and became a more integral part of the day-to-day operations," he said.

Freyberger, his wife, Theresa, and sons, Dylan and Miles, frequently visit a second home in North Carolina's Outer Banks. There, he indulges his lifelong passion for surfing, although, as he noted with a laugh, "I was much better when I was younger."

In many ways, being at Jefferson Lab as CEBAF's director of operations is the ultimate fulfillment of his childhood dreams.

"As a physicist, you're either going to be faculty somewhere or at a lab. It's exciting to be where the great science is going on."

Submitted by DOE's Jefferson Lab