Sandia's Daniel Sinars Z-Crystal

Page 2

Research Highlights . . .

DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

Number 171 November 15, 2004

Updated PVWATTS provides photovoltaic info

Recent enhancements to Version 2 of PVWATTS—Internet-based software that calculates the energy production and cost savings for grid-connected photovoltaic (PV) systems in the United States—allows users to define the system location by the use of ZIP codes or latitude and longitude coordinates. An addition to Version 1 gives users more detailed performance information, including data on energy production for each hour of the year. DOE's National Renewable Energy Laboratory researchers developed PVWATTS to allow the public to quickly obtain performance estimates for grid-connected PV systems. An online survey is currently being conducted to identify future changes to PVWATTS.

[Sarah Holmes Barba, 303/275-3023, sarah_barba@nrel.gov]

Reformer "engine" powers solution for high-temp fuel cells

NETL researchers have invented an "engine" that may resolve the challenge of using high-temperature fuel cells for quick startup applications. The Reciprocating Compression Reformer (RCR) can provide power until the fuel cell warms up, then produce hydrogen for the fuel cell. The RCR uses a reciprocating device, similar in construction to an internal combustion engine, to reform compressed hydrocarbon fuel and an oxidant into a hydrogen-rich synthesis gas. The RCR can provide direct power quickly and/or produce hydrogen streams for other devices. Large scale stationary RCRs could also act as Hydrogen Refilling Stations or Point-of-Use Hydrogen Production facilities. NETL's Office of Science, Technology and Analysis, has recently received a patent for their invention.

[Otis Mills, 412/386-5890, mills@netl.doe.gov]

System tackles perchlorate pollution

A system developed at DOE's Oak Ridge National Laboratory to clean up perchlorate pollution is now also helping scientists determine whether the contamination is natural or man-made. This latter application could be instrumental in tracking environmental perchlorate and determining its source. Conventional treatments use tiny resin beads to trap the perchlorate, but the spent resin becomes contaminated, and disposal is costly or impractical. The Highly Selective, Regenerable Perchlorate Treatment System removes and breaks down perchlorate into harmless chloride and water and recharges the resin so it can be reused many times. The process costs up to 80 percent less than conventional methods and is one of *R&D Magazine's* top 100 inventions for 2004.

[Mike Bradley, 865/576-9553, bradleymk@ornl.gov]

BlueGene tops in teraFLOP/s

DOE's Lawrence Livermore National Laboratory is preparing to take delivery of the first section of its new BlueGene/L supercomputer, part of NNSA's Advanced Computing and Simulation (ASC) program. Secretary of Energy Spencer Abraham announced BlueGene/L has achieved a record breaking 70.72 teraFLOP/s (trillion floating point operations per second) on the industry standard LINPACK benchmark. Though it is only running at one quarter its final size, it is already asserting U.S. leadership in supercomputing. When fully operational early next year, BlueGene/L will study weapons aging, material properties, higher resolution representations of physics in 3D, and achieving a tighter coupling of computational science with experimental science.

[Lynda Seaver, 925/423-3103, seaver1@llnl.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).

New method studies living bacteria cells

Researchers at DOE's Argonne National Laboratory have found a new way to study individual living bacteria cells and analyze their chemistry.

Argonne scientists, collaborating with colleagues from Wichita State, Notre Dame and the University of Southern California, used high-energy X-ray fluorescence measurements for mapping and chemical analyses of single free-floating, or planktonic, and surface-adhered, or biofilm, cells of Pseudomonas fluorescens. The results showed differences between the planktonic and adhered cells in morphology, elemental composition and sensitivity to hexavalent chromium. The biofilm cells were more tolerant of the contaminant, while it damaged or killed the planktonic cells.

The work pioneers a potentially revolutionary new technique for investigating microbiological systems in natural subsurface environments. No previously available techniques had the spatial resolution needed to analyze individual bacterial cells noninvasively and nondestructively. Recent developments at the Advanced Photon Source (APS) at Argonne enabled the production of X-ray beams small enough to probe single bacterial cells.

In these experiments, scientists exposed both planktonic and biofilm cells to elevated concentrations of hexavalent chromium. The researchers then used X-ray fluorescence microscopy to measure the concentrations of elements in individual cells before and after exposure to the heavy metal. The results indicated that X-ray fluorescence analysis had distinguished living bacterial cells from dead cells for the first time. Next, the researchers used the energy tunability of the APS X-ray beamline for spectroscopy experiments on the bacterial systems, showing that the surface adherence of the biofilm cells promoted tolerance to the chromium and reduced its toxicity level.

Finally, when the cells made the transition from the planktonic state to the biofilm state, the scientists observed changes in the concentrations of many transition metals required for bacterial life, suggesting that X-ray fluorescence analysis might be useful for determining whether a bacterial cell is living or dead.

Funding for this project came from the Natural and Accelerated Bioremediation program of the U.S. Department of Energy's Office of Biological and Environmental Research.

Submitted by DOE's Argonne National Laboratory

Imaging the maelstrom at the center of Sandia's machine

Daniel Sinars Z-Crystal

Describing the maelstrom of X-rays released when Sandia National Laboratories' Z machine fires, Daniel Sinars says, simply, "The energies in there are insane." Other than a nuclear bomb, Z is the most powerful generator of X-rays on the planet. Last year, its central mechanism, called a Z-pinch, fused isotopes of hydrogen to create nuclear fusion.

Peering into the center of Z as it fires had been a feat unachievable for a decade, but now, by inserting a two-inch-long crystal that reflects only a single frequency, Sinars' Z-Pinch Experiments and Advanced Diagnostics group has managed to visually filter out the bedlam of more than 99 percent of the energies generated by Z.

By viewing the dissolution of a wire cage about the size of a spool of thread into ionized gas particles nanosecond by nanosecond, Z experimentalists will be able to understand more rapidly and accurately how changes to the wire array will affect the final outcome, in order to fine-tune Z's driving forces.

These alterations will achieve still more powerful outputs for weapons studies and, eventually, controlled nuclear fusion that could produce unlimited energy from seawater.

Describing Sinars' work, Pulsed Power Sciences Center Director Jeff Quintenz says, "It's like being able to find a grain of sand in a sand pile, or a single voice in a crowded coliseum."

Sinars' interest in science was sharpened when he attended the Illinois Math and Science Academy, a magnet school in Aurora, Ill. He earned an undergraduate degree in engineering physics at the University of Oklahoma and his doctorate in applied physics at Cornell. He went to Sandia directly from Cornell.

Says Cornell physics professor and Sinars mentor David Hammer, "Dan has extended backlighting work done elsewhere, but he has done so in the most extremely difficult environment. His implementation had to be novel to make it work."

Submitted by DOE's Sandia National Laboratories