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DOE Pulse
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Research Highlights . . .

Decontamination foam may be best response in chem-bio attack

Emergency personnel responding to the scene of a terrorist release of chemical or biological warfare agents could become victims. If they wait to evaluate, though, an agent could spread and cause even more widespread casualties. The solution may be a foam created at DOE's Sandia National Laboratories that begins neutralizing both chemical and biological agents in minutes. Because it is not harmful to people, it could be dispensed on the disaster scene immediately, even before casualties are evacuated. In laboratory tests at Sandia, the foam destroyed simulants of the most worrisome chemical agents (VX, mustard, and soman) and killed a simulant of anthrax—the toughest known biological agent.

[Howard Kercheval, 505/844-7842, hckerch@sandia.gov]

Exotic celestial objects studied

A collaboration of physicists from DOE's Stanford Linear Accelerator Center and the Department of Defense's Naval Research Laboratory recently launched an experiment to study exotic celestial objects. Part of the Unconventional Stellar Aspect (USA), the experimental telescope will observe bright X-ray sources, including black holes, neutron stars, white dwarfs and other phenomena not observable from Earth-based laboratories. USA will also contribute to applied science and environmental science. It will use X-ray sources to test new approaches to satellite navigation and to conduct the first tomographic survey of Earth's atmosphere, and test new concepts for making spacecraft computers more reliable.

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Insights may aid development of stronger magnets

Research at DOE's Ames Laboratory has led to a better understanding of the solidification process of neodymium-iron-boron permanent magnets and the role of alloying additions. This knowledge may aid manufacturers in producing stronger magnets. As they studied the solidification process, the researchers discovered key aspects that control the microstructural development of Nd-Fe-B magnets. Additionally, they found that the use of select, minor alloying elements increased the strength of the magnets while reducing the heat-treatment time and the number of processing steps. The researchers say their findings should enable manufacturers to lower their production costs, thereby increasing the commercial viability of the magnets.

[Susan Dieterle, 515/294-1405, dieterle@ameslab.gov]

Jefferson Lab experiments challenge theories

Four experiments at DOE's Jefferson Lab are challenging the conventional wisdom that the proton's charge and magnetic moment are equal. Researchers have found that the quark-carried charge distribution within a proton is larger than its magnetic distribution. Currently, the reason for this dispariy is not known or understood. While the findings don't appear to challenge the basic tenets of current quantum chromodynamics theory, the theory can't yet account for whatever underlying mechanism is responsible for the difference in charge and magentic moment. Additional experiments are scheduled to be conducted at Jefferson Lab in the coming months.

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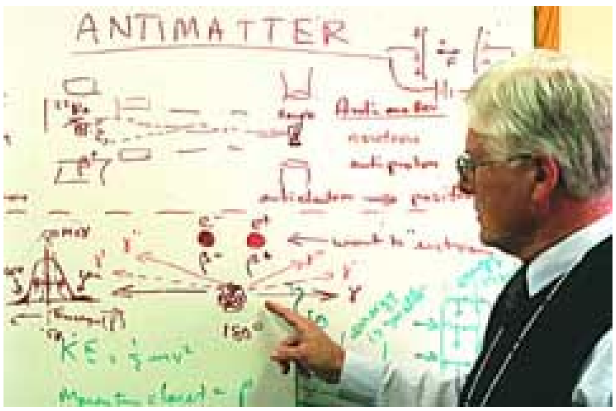
DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. ***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).

Probing dots with positrons

Imagine the resolution of your TV with each pixel thousands of times smaller than a hair's width, or the speed and size of a computer made from a multitude of semiconductors even smaller than those pixels.

The very real technology behind these imaginings is rooted in quantum dots, particles so small that the normally predictable relationship between energy's components of wave and particle become tattered by ambiguity and mired in quantum physics.



INEEL's Denison uses matter-antimatter reactions to probe the intricacies of "quantum dots."

Harnessing quantum dots' strengths, however, requires a tool to study and develop them. Physicists Art Denison at the Idaho National Engineering and Environmental Laboratory and Kelvin Lynn at Washington State University think they've got just the tool.

"We're using antimatter to probe quantum dots," said Denison. If successful, researchers will be able to use their technique to study physical properties of the dots and to fine tune their production to have desired characteristics.

The quantum dots used by Denison and Lynn are cadmium-selenium or silicon-germanium spheres produced by labs at the University of California's Berkeley and Davis campuses. Because of a quantum dot's size, internal electrons don't have enough room to behave respectably. Inject a dot with energy—via sunlight or an electrical outlet—and the excited electron emits extra energy due to its confinement to limited space (similar to a child in a minivan). This energy can be harnessed (unlike the child's) as a variety of colors for light-emitting applications, or can be converted into a current for highly efficient solar cells or semiconductors.

How much extra energy the excited electron emits depends on the size of the dot. The smaller the dot, the more squeezed the electron, and hence the greater degree of extra energy.

Denison and Lynn have been using anti-electrons, or positrons, to size up the quantum dots. When matter and antimatter collide, they explode and give off energy. The researchers shoot a positron into a quantum dot, where it plows into an electron and causes an explosion of easily measured gamma rays. Since the energy of the gamma rays changes with the extent of electron confinement, the researchers can determine the size of the particles.

"The data are consistent with quantum confinement but the jury's still out," said Lynn. The researchers are performing more experiments to rule out defects in the particles. "Those defects on the surface can trick you into thinking you're seeing quantum effects. We're actually probing for both quantum confinement and surface defects," said Denison.

Submitted by DOE's Idaho National Engineering and Environmental Laboratory

Pacific Northwest's Balmer takes aim at environmental issues

When the next generation of automobiles begins rolling off the assembly lines shortly after the start of the next century, Mari Lou Balmer's research may be partially responsible for helping these vehicles meet new environmentally-friendly emissions standards.

"Vehicles of the future will have to meet stringent emissions goals set by the EPA. In addition there is an incentive to reduce the emission of greenhouse gases and that means wider use of diesel engines in vans and sport utility vehicles because they produce less carbon dioxide. Unfortunately, big improvements are required in exhaust treatment devices to remove nitric oxides before diesels can become more widely used," she said.

Balmer, a materials scientist, is on a team of researchers at DOE's Pacific Northwest National Laboratory who are working closely with scientists and engineers from the big three auto makers on a solution to the problem.

"We're using a plasma catalyst concept and have designed a catalyst that appears to be very promising. We're on track to meet emission standards by 2004 when the new vehicles are to begin using Compression Ignition Direct Injection (CIDI) engines, which is a type of diesel engine."

When she isn't working on auto exhaust issues, Balmer turns her attention to solving another environmental problem dealing with radioactive waste on DOE's Hanford Site.

"We've developed a process to immobilize cesium in ion exchange columns after the cesium is removed from waste stored in giant, underground tanks. It's a heat treatment process which converts the contents of the column into a ceramic that will entrain the cesium in its matrix and prevent it from leaching out," says Balmer.

Balmer and others on the team have already received a patent on a ceramic to immobilize cesium and they are expecting a patent for their work with other researchers to develop the auto exhaust after-treatment technology.

Submitted by DOE's Pacific Northwest National Laboratory