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DOE Pulse

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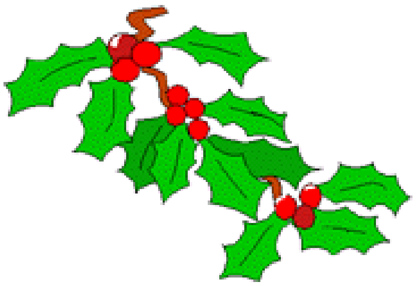
Research Highlights . . .



Happy Holidays

Pulse will return on Jan. 10

Ames researchers discover second-hardest material

Researchers at DOE's Ames Laboratory made a gem of a discovery while tinkering with an unlikely material—it's the second-hardest bulk substance after diamond. By introducing a small amount of silicon and other additives into an alloy of aluminum, magnesium and boron, they created a material slightly harder than cubic boron-nitride, the material now ranked second. The material is also expected to cost substantially less with an estimated price of about $700 per pound compared to cubic boron-nitride's cost of up to $7,000 per pound and diamond's cost of about $2,000. Ames researchers hope that experiments with other additives will further increase the material's hardness.
[Susan Dieterle, 515/294-1405, dieterle@ameslab.gov]

Argonne's brilliant light shines on immune system

The first detailed pictures of key immune system cells locked onto fragments of a foreign substance provide new clues about how the immune system identifies enemy threats, scientists say. The investigation was done by a team of researchers at Dana-Farber Cancer Institute, using the nation's most brilliant X-ray beams at the Advanced Photon Source at DOE's Argonne National Laboratory. The three-dimensional images show that the cells' docking equipment—or "receptors"—bind to a relatively short portion of the protein fragment. The finding means that scientists can now focus on precisely that area when studying how the cells recognize harmful intruders and bring about their destruction.
[Catherine Foster,630/252-5580, cfoster@anl.gov]

Earth-bound 'star' impersonates black hole, neutron star

The Z machine at DOE's Sandia National Laboratories, capable of creating temperatures rivaling those of the sun, is helping physicists examine what happens to iron in the grip of black holes and neutron stars. Iron is among the most complicated of elements widespread in the universe, and among the hardest to understand. Researchers from Sandia and Lawrence Livermore national lab are also helping astronomers trying to interpret images from the billion-dollar Chandra X-ray observatory now orbiting Earth, as well as two billion-dollar X-ray orbiting observatories expected to be sent aloft from Europe and Japan in the next year.
[Howard Kercheval, 505/844-7842, hckerch@sandia.gov]

Sensor could increase safety of eye surgery

Precision is crucial during eye surgery—a slight miscalculation could result in partial blindness and damage to the retina. But a new sensor being developed at DOE's Pacific Northwest National Laboratory could reduce those risks by alerting surgeons to the location of critical retinal tissues. Pacific Northwest researchers have designed and built a proximity sensor that could be connected to an endoscope, the tool surgeons use when operating on the back of the eye. The sensor calculates distance of the endoscope's needle to the retina and tissue. The proximity sensor also could be applied to other surgery, such as spinal operations that require surgeons to know the location of nerves.
[Staci Maloof, 509/372-6313, staci.maloof@pnl.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 crystals for the next millennium

A kind of photonic frenzy broke out in 1990 when DOE's Ames Laboratory physicists Kai-Ming Ho, Che-Ting Chan and Costas Soukoulis theoretically proved that the diamond structure has a genuine, three-dimensional photonic bandgap, a range of forbidden frequencies within which a specific wavelength in the electromagnetic spectrum is blocked and light is reflected.

Today, the Ames team and their collaborators at Sandia National Laboratories may be on the verge of achieving three-dimensional optical photonic bandgap crystals—an accomplishment that could revolutionize light control.

Ames Lab researchers Kai-Ming Ho (left) and Rana Biswas examine an image of a PBG crystal built at Sandia National Laboratories using Ames Lab's original layered lattice design.

Engineering PBG crystals with bandgaps to match the wavelengths scientists wish to block would enable them to manipulate light. The challenge is to design and construct photonic crystals that operate at infrared and optical wavelengths where a greater number of potential applications exist.

A milestone in PBG crystal research came in 1992 when Ho developed a variation of the diamond structure—a photonic crystal that could be built in a layer-by-layer fashion. The Ames team began using the new design to build smaller photonic crystals for which they envisioned bigger and better applications.

The novel layered lattice design ultimately drew the attention of Sandia's Shawn Lin. He wanted to make the Ames structure using a "backfilling" technique with silicon bars. In collaboration with the Ames design team of Ho, Rana Biswas and Mihail Sigalas, Lin and fellow Sandia researcher Jim Fleming successfully fabricated the Ames structure in 1998, bringing the bandgap into the near-infrared. Photonic crystals operating in that region could tremendously improve the efficiency of optical switches for fiber-optic communications, as well as reduce energy loss and improve efficiency in many electrical devices.

As the year 2000 approaches, Ames and Sandia are concentrating on finding new uses for all the photonic crystal research coming out. And both research teams expect the PBG crystal frenzy to pay off big in the next millennium.

Submitted by DOE's Ames Laboratory

Budding experimentalist really hands-on

Gary Rutledge is one of the hardworking graduate students who has learned his trade at DOE's Thomas Jefferson National Accelerator Facility (Jefferson Lab). He expects to graduate from the College of William & Mary this spring with a Ph.D. in experimental particle physics.

By helping his father rebuild and repair old airplanes during his childhood, Gary learned that discipline and precision pays off by seeing those old planes fly again, but his interest turned from the engineering to the quest of discovering why things worked the way they do. As Gary puts it, "Asking those questions eventually gets you down to the atomic levels. Physics just had the answers. Physics courses were the ones that gave me the biggest challenge".

Gary arrived at Jefferson Lab in 1994 with a full set of high-precision machinist tools designed for the aircraft industry and experience in using them. With his electronics background and a degree in physics, Gary got right to work in one the Jefferson Lab experimental areas. It was mechanically complex and, in the beginning, not very physically reliable. So Gary was able to get invaluable experience at the ground level by working to develop the cryogenic target used to conduct experiments in that area.

Later, he oversaw the construction of some detectors in another experimental area from design to installation. He's certain few others have had a chance to drive detectors at 30 miles per hour on the interstate at two in the morning for delivery to the Lab.

Gary says being a graduate student at Jefferson Lab has been a fantastic experience. The working conditions are good, the attitudes of the people at the Lab are excellent and there's no hesitancy in working together. Gary only hopes that his career as an experimental physicist can be a good as his experience at Jefferson Lab.

Submitted by DOE's Jefferson Lab