Robert Wilson's Fermilab legacy

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Research Highlights . . .

Simulations tell the story

Cai-Zhuang Wang and Kai-Ming Ho, theoretical physicists at DOE's Ames Laboratory, have applied their tight-binding molecular dynamics (TBMD) method to simulate changes on diamond surfaces under ablation with laser pulses. TBMD allows scientists to study the structures and dynamics of complex systems at the atomistic level. The simulations revealed that because ultrashort femtosecond pulses cause the electrons to jump into excited states before the heat from the laser pulse is transmitted to the atoms, the ablation ejects the top diamond layers by a non-thermal mechanism and leaves a smooth surface. This finding may be significant in microelectronics and cutting-tool applications.

[Saren Johnston, 515/294-3474, johnstons@ameslab.gov]

Toroid Cavity Detector provides inside story

Scientists at DOE's Argonne National Laboratory have taken the guesswork out of a popular guessing game: "How many beans in the jar?" Their invention, a toroid cavity imager that employs nuclear magnetic resonance technology, reveals not only how many there are, but how many of each flavor, and exactly where every last one is located. Moisture, degradation products, and other chemical reactions can be detected and measured within sealed containers. The device's high resolution and sensitivity make it attractive for waste monitoring, safety and security applications, and nondestructive evaluation of commercial packaged goods. Funding support comes from DOE's Office of Environmental Management.

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X-Ray vision

Iodine-based contrast agents make soft tissues visible on X-rays. But these "dyes" can be harmful to some patients. So scientists from DOE's Brookhaven National Laboratory, in collaboration with Schering AG, a German pharmaceutical company, have set their sights on a safer imaging method. The Germans are working on a gadolinium-based contrast agent with fewer side effects and more-efficient absorption of high-energy X-rays. Brookhaven, in turn, is developing a monochromater device to select the portion of the X-ray spectrum that will make that agent most visible on radiographs. End result: better images and lower X-ray doses for patients.

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Improving the performance of arterial stents

A collaboration between Duke University Medical Center and the DOE's Thomas Jefferson National Accelerator Facility (Jefferson Lab) is working to improve future angioplasty techniques. In present day angioplasty, a balloon like catheter is used to expand an artery, and a small "wire cage" stent is installed to hold the artery open. In the new technique, the emission from the activated stents delivers a small dose to the artery walls. Irradiated stents seem to prevent scar tissue from forming, allowing the angioplasty to last longer and perform better for the patient. Stents will be irradiated using Jefferson Lab's high average power Free Electron Laser accelerator beam for animal experiments. If the animal studies go well, human trials will follow.

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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).

PPPL physicists work to improve TV technology

During the next decade, televisions will change substantially with the advent of High Definition Television (HDTV) and flat panel, hang-on-the-wall displays that have been a staple of science fiction.

At DOE's Princeton Plasma Physics Laboratory, researchers Hyeon Park and Hideo Okuda are working on an experimental diagnostic method and a computational model that will aid designers of flat panel displays. Their efforts will allow designers to better characterize the plasmas used to produce light in the displays. Plasmas are ionized gases. The researchers' work may lead to less expensive displays that are larger, last longer, and provide higher resolution images.

From left are PPPL researchers Hyeon Park and Hideo Okuda with students Carl Li and Jill Foley. On the table near Dr. Park is a plasma device similar to a plasma display cell.

The clarity of state-of-the-art plasma displays is marginal and they are dimmer than conventional television sets. To meet the clarity requirements for true HDTV, plasma displays must sustain or improve the brightness in a smaller plasm cell, so that the gray scale and resolution can compete with HDTV based on other techniques.

Park and Okuda believe that experimental and theoretical techniques developed to study plasmas in fusion energy research—PPPL's primary mission—can be used to improve plasma display technology. But the challenge is formidable. Whereas the size of fusion plasmas may be measured in meters, the plasma cells used in a display have dimensions of 200 microns or less. Fusion plasmas last a few seconds, while those in a display have about a one-microsecond lifetime.

Okuda is developing a computational code which will provide a realistic model to predict the brightness of the ultraviolet light produced by the plasma. Okuda's calculations require the development of a kinetic model to compute the energy distribution in the short-lived plasma. He does this by clamping many plasma particles into super-particles, thereby reducing computational time.

Tests of Okuda's theories will require precise, direct measurements of electron density in the one-microsecond, 200-micrometer plasma—a challenging task. Fortunately, Park has invented an interferometric technique employing a visible-light laser, rather than longer-wavelength (microwave or far-infrared lasers) conventionally used to measure the range of plasma density expected in a plasma display cell. The short-pulse, continuous-wave visible laser not only allows measurements to be made on the tiny cells of a plasma display, but provides adequate spatial resolution since the visible beam can be focused to a spot much smaller than cell size. Park's method has the potential to determine both the electron density and temperature of the plasma cell—important characteristics in determining performance.

Submitted by DOE's Princeton Plasma Physics Laboratory

Robert Wilson sculpted a unique presence for Fermilab

Robert Rathbun Wilson was a Wyoming cowboy who built the world's highest-energy particle accelerator laboratory with the eye of an artist, the shrewdness of a banker and the conscience of a human rights activist. He died January 16, 2000 in Ithaca, New York, near Cornell University. He was 85.

Wilson, who served as director of DOE's Fermilab from 1967 to 1978, was not only a pioneering scientist, but a powerful spokesman for science. In his testimony before the Congressional Joint Committee on Atomic Energy in 1969, he was asked by Rhode Island Senator John Pastore about the value of high-energy physics research in the support of national defense.

"It has nothing to do directly with defending our country, except to make it worth defending," Wilson said.

Robert Wilson

Wilson—physicist, artist, sculptor, writer—put his personal stamp on every aspect of Fermilab (originally the National Accelerator Laboratory). He painted many buildings in bright primary colors; he patterned his design for the laboratory's headquarters, 16-story Wilson Hall, after a cathedral in Beauvais, France; and he established a herd of American bison as a symbol of the laboratory's work at the frontiers of physics. Wilson had been born in Frontier, Wyoming, on March 4, 1914.

Wilson had been a young leader on the Manhattan Project to build the first atomic bomb during World War II. Wilson adapted the model of that wartime partnership combining government resources and academic scientists, to the peacetime pursuit of civilian science, in particular to the construction of large particle accelerators for high-energy physics. Fermilab accelerators have produced two of the major discoveries in particle physics: the bottom quark, in 1977; and the top quark, in 1995.

Plans are being formed for a memorial service for Wilson at Fermilab in the spring.

Submitted by DOE's Fermi National Accelerator Laboratory