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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

A fascination with flame

For more than a million years, humans have been using fire. Surprisingly, there are still things we don't know about flames. Scientists at DOE's National Energy Technology Laboratory are using particle image velocimetry to understand why and how flames oscillate as their fuel-to-air consumption ratio is decreased. When new fuel-flexible gas turbines are designed run at these "lean-burn" conditions, they will produce electricity with less pollution. That's good. But flame oscillations could set up vibrations in the machinery—vibrations strong enough to tear a $100 million engine apart. That's bad. Models incorporating NETL's research results could help solve the problem.

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First "Zero Energy Home" ready in June

The first home in the nation to be built under DOE's Zero Energy Home Program is set for June completion in California. DOE and its National Renewable Energy Laboratory have partnered with Davis Energy Group and Centex Homes to construct the Zero Energy Home at the Los Olivos development in Livermore. A Zero Energy Home combines solar energy technologies with advanced energy-efficient construction. Like virtually all homes, a Zero Energy Home is connected to the utility grid, but because it produces as much energy as it consumes, the homes are considered to achieve "net zero" energy consumption.

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Neutrino-fueled stellar kickstart

In a core-collapse supernova explosion, it is believed that the shock wave stalls in the stellar core and is later reenergized by nearly massless, radiation-like particles called neutrinos. DOE's Oak Ridge National Laboratory, a leader in simulating neutrino transport, is applying this expertise to developing 3D simulations that will explore the role played by convection—transfer of heat by the circulation of the core's proton-neutron fluid—in aiding this shock revival process, as well as the role played by the star's rotation and magnetic field. ORNL researchers are also interested in using these simulations to predict the emitted gamma rays and gravitational waves (ripples in space-time) from supernovae.

[Carolyn Krause, 865/574-7183, krausech@ornl.gov]

Scientists see a vivid picture of DNA repair

Damaged DNA left unrepaired can lead to mutations, cancer and other abnormalities. To better understand how DNA is repaired, researchers at DOE's Pacific Northwest National Laboratory have for the first time applied a powerful microscopic process, called single-molecule spectroscopym to research focused specifically on interactions between DNA and DNA repair proteins. The researchers also are developing advanced chemical physics tools to study one of the first steps of this process: how the damaged DNA is recognized so that it can then be repaired. By better understanding how the repair mechanism works and why it occasionally fails, researchers hope doctors may one day be able to augment the repair process.

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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).

Researchers reveal the secrets of the stars

To reach for the stars is no figure of speech for scientists at DOE's Argonne National Laboratory and the University of Chicago. For them, it is the literal truth.

Using an instrument available only at Argonne, they study microscopic interstellar dust grains that meteorites have transported to Earth. Exploding stars launched these dust grains into space billions of years ago. The grains then got mixed into clouds of interstellar dust that collapsed to form the sun, the planets and meteorites. These grains now reveal details about how stars evolved over billions of years to produce the elements needed to form the Earth and all other objects in the solar system.

The stories all tell the tale of nucleosynthesis, the process by which the universe creates the elements, including iron, gold and silver. But some of the grains tell a story that no one has heard before.

Interstellar dust grain can reveal the secrets of the stars.

After the Big Bang occurred about 14 billion years ago, the universe contained only two elements: hydrogen and helium. Atoms of hydrogen, helium and other light elements fused in the first stars to form elements such as carbon, oxygen and nitrogen, which are essential to life. Exploding stars and dying stars called red giants make elements heavier than iron by adding subatomic particles called neutrons to lighter elements.

In a collaboration that spans more than a decade, the Argonne-Chicago team has focused its attention on measuring the isotopes of heavy elements in interstellar grains. They are like fingerprints left behind by certain kinds of stars. Argonne is the only laboratory in the world that can identify these fingerprints, using a technique called resonance ionization mass spectrometry.

The grains, identified as silicon carbide, graphite, and, most plentifully, diamond, typically measure two or three microns in diameter. This is small enough for 15 or 20 of them to fit comfortably across the width of a human hair.

Submitted by DOE's Argonne National Laboratory

SANDIA RESEARCHER IN A 'REALLY COOL' LIGHT

Shawn Lin

The figurative light bulb that blinked on over Sandia researcher Shawn Lin's head may turn out to be more than a cartoon device signaling a new idea. In a pun-ish play on words, it is a really cool idea that could take the heat off light bulbs.

Tungsten-filament bulbs—the most widely used light source in the world—are infamous for generating more heat than light. But a microscopic tungsten lattice—in effect, a tungsten filament fabricated with an internal crystalline pattern—developed at DOE's Sandia National Laboratories by Lin and research colleague Jim Fleming has the potential to transmute the majority of this heat into light.

The first step toward this goal, which could raise the efficiency of an incandescent electric bulb from 5 percent to greater than 60 percent, was reported in the May 2 issue of *Nature.*

Taken to fruition, the technology would greatly reduce the world's most vexing and important power problem—the required excess electrical generating capacity and costs to consumers caused by inefficient lighting, as well as the environmental impact of unnecessary power generation.

Lin, who earned a PhD in electrical engineering at Princeton in 1992, joined Sandia in December 1994. Subsequent research led to development of a photonic lattice that can bend and redirect light, and that technology played a key role in development of the more efficient light bulb.

His work earned him recognition by the Chinese Institute of Engineers/USA society earlier this year as one of 17 researchers chosen nationwide to receive the first Asian American Engineer of the Year award. He was cited for work that "opens the door for totally integrated optical systems that might replace traditional electronic devices in communication and eventually, maybe in computers."

Submitted by DOE's Sandia National Laboratories