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## Research Highlights . . .



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### Ames chemists resolve century-old controversy

DOE [Ames Laboratory](#) senior chemist Andreja Bakac and assistant scientist Oleg Pestovsky have resolved the 100-year-old debate over the mechanism that triggers one of the most powerful oxidizing reactions available for breaking apart organic molecules. They have generated, characterized and ruled out iron (IV) as the crucial intermediate in the Fenton reaction, a complex and pervasive reaction in matters associated with biological systems, environmental and atmospheric processes, and catalytic chemistry. Their indisputable research results establish hydroxyl radicals (OH radicals) as the crucial Fenton intermediates. The illuminating work was done in collaboration with researchers at [Carnegie Mellon University in Pittsburgh](#) and the [University of Minnesota in Minneapolis](#).

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### Argonne helps 'power' protection for soldiers

Next-generation soldiers will wear vests with a battery to power the many high-tech devices that modern soldiers use in battle. DOE's [Argonne National Laboratory](#) is developing the materials and cell chemistry for that battery. Modern military personnel rely on non-rechargeable batteries to power communications, night vision goggles and global-positioning sensors. In an ongoing project for the U.S. Army Communications-Electronic Research & Engineering Center, Argonne is developing battery chemistry for Quallion LLC's battery pack for the Power Vest. DOE's [Office of Energy Efficiency and Renewable Energy](#) provided the original funding to Argonne in 1998 to improve safety and calendar life for these energy-storage devices.

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### Spinning quarks

Just as a top spins on a table, the tiny quarks inside protons and neutrons (nucleons) also spin. Now a complex calculation by theoretical nuclear physicists at DOE's [Jefferson Lab](#) has revealed that a quark's spin may be altered by the surroundings of the nucleon in which it resides. The [surprising result](#) comes from a calculation of the spin-dependent structure functions for nucleons inside the nucleus and for free nucleons - those outside the nucleus. The structure functions provide information on how the quark spins are organized inside the nucleon. [The research](#) has been published in *Physical Review Letters*.

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### Portable nuclear material detection system

Researchers at DOE's [Savannah River National Laboratory](#) have developed a lightweight, portable system that can rapidly detect the presence of nuclear materials in sealed containers. Using sensors arrayed linearly and encased in fabric, the RadRope system can be dangled in the small gap between stacked shipping containers on a cargo ship. As the inspector walks along the top containers, a hand-held PDA shows an alarm when any sensor in the array detects radiation levels above background radiation. The system, which can be easily used by one person, detects gamma and neutron radiation. The length of the RadRope system can be easily customized for different uses.

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# Terror of the Tudor Seas suffers from sulfur

**H**enry VIII's warship, the Mary Rose, wreaked havoc on the French navy for 34 years until she was wrecked in 1545. Salvaged from the sea in 1982, she now rests in the Mary Rose Museum in Portsmouth, England. Pieces of her helm recently travelled to DOE's [Stanford Linear Accelerator Center](#) in Menlo Park, Calif., and Grenoble, France where intense x-rays pierced the wood analysing the sulfur and iron within.

The results indicate the Mary Rose's surviving wood contains two tons of sulfur uniformly distributed within the 280-ton hull. Over time, sulfur can convert to sulfuric acid, which could slowly degrade the stability of the wood. Iron from corroded iron bolts catalyzes the oxidation of sulfur



*A conservator works on Henry VIII's warship, the Mary Rose. (Photo: The Mary Rose Trust)*

into sulfuric acid. The prevalence of sulfur and iron in the oak timbers poses long-term preservation challenges, but the new information can also help to overcome the threats.

The highest concentrations of sulfur were found in areas between the wood cells, made of lignin that acts like glue to hold cells together. The lignin reacting with hydrogen sulfide produced by marine bacteria, accumulated sulfur in surprising amounts. Other marine bacteria destroyed the cellulose cell walls, leaving a hollow "house of cards" once the ship was pulled from the water.

The ship is in no immediate danger because the acid gets washed away during conservation, but the researchers suggest that long-term preservation requires chemical treatments to remove or stabilize the remaining iron and sulfur compounds, and reducing humidity and access to oxygen.

"The method used in these studies—synchrotron radiation-based x-ray absorption spectroscopy—is a particularly powerful tool," said Stanford Synchrotron Radiation Laboratory Professor and Assistant Director Britt Hedman. "It can be used directly on the samples without any pretreatment that could change them. It provides not only information on which chemical element, such as sulfur, is present, but also the type of chemical form, or species, it has, and therefore can directly provide the chemical pointer towards the proper preservation approach."

Submitted by DOE's [Stanford Linear Accelerator Center](#)

## FREELAND OVERCOMES HURDLES OF PHYSICS CAREER BREAKS

"Elizabeth Freeland took a long road to arrive at crunching numbers for Lattice QCD in the Theoretical Physics Department of the Department of Energy's [Fermilab](#). After receiving her doctorate in condensed-matter physics from [Johns Hopkins University](#) in 1996, Freeland took a five-year career break



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for motherhood before turning back to the field. She was met with a series of hurdles built by her absence. "There's this mindset that if you take time to do anything but physics, then you're not serious," Freeland said.

Research opportunities required a grant. Grants required her to have a full-time affiliation with less than a five-year break after graduate school. As a mother of two and a part-time physics teacher at the School of the Art Institute of Chicago, Freeland had neither. "If I couldn't get a grant, I couldn't have day care, and if I couldn't get day care, I couldn't do the work," she said.

Freeland eventually earned enough money from teaching to pay for day care while conducting part-time research at Fermilab, which she said has been supportive of her situation. Then she found a grant from the American Association of University Women for which she was eligible. Her application was accepted, and the one-year grant allowed her to start at the lab full-time in July.

Freeland, who explores the issue on her personal website says the traditional method of awarding grants and hiring, as well as cultural attitudes toward career breaks, sets many women up for failure. "You should be able to sit down at a lunch table and say 'When is a good time to have children or how can I deal with this?'" she said. "You should be able to ask that question to a group of physicists and not have it looked at as a negative."

Submitted by DOE's [Fermilab](#)