



Sandia's  
Anup Singh

## Research Highlights . . .

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### Most complete human blood-plasma proteome map to date unveiled

Researchers at DOE's [Pacific Northwest National Laboratory](#) have identified an astounding [4,000 distinctive proteins](#) in human blood plasma, a critical step toward cataloging biological markers for early diagnosis of cancer and other diseases. The number is 10 times the amount previously identified, said Richard D. Smith, a senior scientist and Battelle Fellow at PNNL. Smith said the large coverage was important because proteins from distressed cells in tissues can leak into the blood stream and might be found in plasma, given sufficiently sensitive methods of analysis. A fluctuation in the abundance of blood plasma proteins from presumed normal, healthy levels may signal the early onset of diseases.

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### Look Ma, no belts . . .

Broken drive belts in your car might be a thing of the past because of a technology being developed at DOE's [Oak Ridge National Laboratory](#). Electric drive motors could replace the belts that run compressors, water pumps and oil pumps of hybrid and fuel cell vehicles. The motors, however, require inverters, and researchers are developing an integrated inverter that would work with multiple motors. An inverter converts DC voltage to AC. Some of the inverter components can then be shared among the motors, making the drive system smaller and less costly. A simulation study has confirmed the benefits of the integrated inverter drive. A proof-of-concept setup is being assembled and laboratory testing will follow.

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### Laser tech lifts commercial aircraft parts

There's more life in store for critical components for commercial aircraft. That's the result of an advanced laser peening technology developed by researchers from DOE's [Lawrence Livermore National Laboratory](#) and a New Jersey firm. The payoff is already proving to be huge: turbine engine parts that last longer, reduced maintenance costs, and annual savings of hundreds of millions of dollars. The breakthrough that provides these benefits is a powerful LLNL laser and shock-generation technology used by Metal Improvement Co. Inc. of Paramus, N.J., to treat the surface of metal parts. "This is 21st century technology that will enable engineers to design aircraft parts that are safer, lighter, perform better and are more economical," said Lloyd Hackel, leader of LLNL's Laser Science and Technology Program and initial developer of laser peening at LLNL.

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### NREL highlights leading utility Green Power programs

DOE's [National Renewable Energy Laboratory](#) released its annual ranking of leading utility "green pricing" programs that allow consumers the choice of supporting additional electricity production from renewable resources such as solar and wind. More than 500 utilities in 33 states now offer these programs. Using information provided by utilities, NREL develops "Top 10" rankings of utility programs in the following categories: total sales of renewable energy to program participants, total number of customer participants, customer participation rate and the lowest price premium charged for a green pricing service using new renewable resources.

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# Laser method could explain groundwater's odyssey

The Sahara Desert was once a lush, green landscape dotted with lakes and ponds. Evidence of this past verdancy lies hidden beneath the sands of Egypt and Libya, in the form of a huge aquifer of fresh groundwater. An international team of geologists and physicists has found that this groundwater has been flowing slowly northward (at about the rate grass grows) for the past million years.

Determining residence times and flow velocities of groundwater in aquifers is a vexing challenge. The extremely rare radioactive isotope krypton-81 (half-life of 229,000 years), which is produced by cosmic rays in the atmosphere, could be an ideal groundwater chronometer on the million-year time scale, but it has been nearly impossible to measure because of its low abundance. There is only one atom of krypton-81 in a trillion atoms of atmospheric krypton, a rare gas to begin with, and krypton is absorbed only slightly by water.

Recently, scientists at DOE's Argonne have developed a laser-based method to count individual atoms of krypton-81 and measure its abundance accurately. Known as ATTA, for Atom-Trap Trace Analysis, this new, ultrasensitive method could revolutionize the scientific study of such topics as continental groundwater flow, long-term glacier motion, and seawater circulation through the ocean floor, say the researchers.

The researchers, from Argonne, the University of Illinois at Chicago, State University of New York at Buffalo, and the University of Bern report the most extensive measurements yet made for krypton-81 in groundwater. In the first application of the ATTA method to a groundwater investigation, this team visited the Western Desert of Egypt to sample krypton from the Nubian Aquifer groundwater, which was reputedly old but of unknown age.

To obtain a sufficient amount of krypton for the ATTA measurements, the team had to extract dissolved gases from thousands of liters of groundwater in the field, using a device invented by the Swiss members of the team. The gas extracted from each well was compressed into steel containers and shipped to Bern, where the trace amount of krypton in each sample was purified and delivered to Argonne for analysis of krypton-81. ATTA measured the ratios of krypton-81 to ordinary krypton, which ranged from about five to 53 percent of that in the air, corresponding to groundwater ages of 200,000 to 1,000,000 years.

Based on these data, it is possible to estimate the direction and velocity of the groundwater flow, which is about one-to-two meters [yards] per year toward the north, and to determine the recharge location in southwest Egypt. This confirms results from some previous numerical hydrologic models, but refutes others. Isotopic characteristics of the water itself indicate that it was transported by air masses traveling long distances over North Africa from the Atlantic Ocean, thus reflecting climate conditions much different from the present during the past million years. Changing climate patterns turned this green oasis into today's desert.

The research was funded primarily by the National Science Foundation and DOE.

*Submitted by DOE's Argonne National Laboratory*

## SANDIA DENTAL RESEARCH COULD AID MILLIONS IN U.S. ALONE

At a recent R&D symposium at Sandia National Laboratories' California site, bioresearcher Anup Singh wowed the audience with his tales of life in India and the non-traditional route that brought him to one of the nation's premiere defense laboratories. He was born in eastern India, not far from where Buddha attained enlightenment, but joked that that was all they had in common. After attending engineering school in Bombay and graduate school in North Carolina, he



*Anup Singh*

continued west to the DOE lab's Livermore campus.

Singh's current work at Sandia, however, is serious business for the millions of people in the United States who suffer from periodontal, or gum disease. He is the principal

investigator on a project dubbed "microchip meets a dentist" that will result ultimately in a miniaturized device that can analyze saliva for gingivitis infection, which triggers inflammation leading to bone loss in the jaw. Roughly 20-40 million adults in the United States suffer from gum disease and the treatment cost may run into billions of dollars annually.

The project is the first at Sandia—with Sandia being the lead institution—funded by the National Institutes of Health, and it's slated to run through 2006.

The portable system, says Singh, will employ electrokinetic separations and immunoassays for detecting biomarkers of periodontitis. Analyzing saliva has many advantages, including ease of sample collection (Singh and his colleagues affectionately call it the "spit project") and the potential for tracking other medical conditions.

Though dentistry and national defense may seem an odd match, Singh says that developing devices for medical diagnostics is a logical extension of the expertise Sandia has developed for detection of chemical and biological agents.

*Submitted by DOE's Sandia National Laboratories*