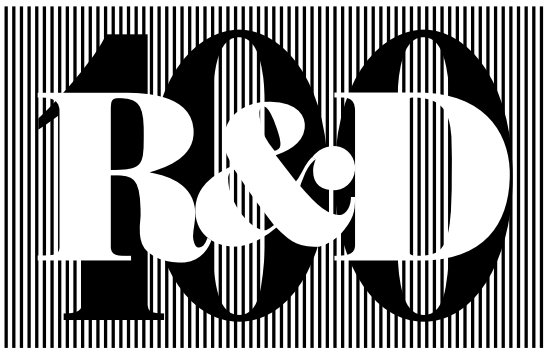
LOS ALAMOS NATIONAL LABORATORY
WHERE SCIENCE MAKES A DIFFERENCE

DATELINE
LOS ALAMOS

LOS ALAMOS CAPTURES ANOTHER SIX R&D 100 AWARDS

INTERNATIONAL AWARDS PROGRAM HONORS TECHNOLOGIES THAT BENEFIT SOCIETY

Los Alamos, for the second year in a row, has topped hundreds of competing academic, industrial, and government research facilities to win six 1995 R&D 100 Awards. R&D Magazine's international awards program, now in its 33rd year, honors the most significant products, materials, processes, software, and systems with commercial promise. Technologies are nominated in an open competition, and the Illinois-based magazine uses technical criteria to pick the most unique, important, and useful.



This is the third time Los Alamos has won more R&D Awards than any other institution. It brings Los Alamos' total to 44

awards in the past eight years, one-third more than any other organization during the same period.

This year, for the first time, the magazine honored one of Los Alamos' nuclear weapons technologies. The hydride-dehydride process for recycling plutonium from nuclear weapons was recognized for its environmental benefits and potential impact on global arms control.

R&D Magazine also recognized five other Los Alamos technologies: a cross-country supercomputer link, a novel treatment for enlarged prostates, a technique for identifying chemicals or chemical weapons agents, a tough chemical microsensor, and a filter that removes heavy metals.

"Los Alamos' success in developing outstanding technologies with commercial potential proves that the national laboratories can help solve complex problems of national importance where science makes a difference," said Pete Lyons, director of Los Alamos' Industrial Partnership Programs office.

The six award-winning Los Alamos inventions are described on the following pages.

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HYDRIDE-DEHYDRIDE RECYCLE PROCESS

BREAKTHROUGH TECHNOLOGY FOR DISMANTLING NUCLEAR WEAPONS

This new recycling process is a one-step, zero-waste method of recovering metallic plutonium from the thousands of nuclear weapons built during the Cold War. The process eliminates the environmental hazards associated with other plutonium recovery methods.

Plutonium recovery traditionally involves a multistep process in which plutonium is leached out with acids, isolated, converted to an oxide, and reduced to a metal. However, this traditional method works for only a few types of weapons and generates large amounts of mixed waste, which is hard to dispose of because it contains both radioactive and hazardous components.

← Process developer Bart Flamm demonstrates the hydride-dehydride processing unit, which is contained inside a glove box to keep hazardous materials isolated.

Los Alamos' new Hydride-Dehydride Recycle Process takes advantage of plutonium's strong affinity for hydrogen gas, a reaction that forms plutonium hydride. The reaction takes place in a vacuum chamber inside a glove box, where a heated crucible in the lower part of the chamber creates a hot zone. A worker places the weapon component in the upper cold zone and introduces a small amount of hydrogen gas emitted by a heated uranium-hydride storage bed.

The gas reacts with some of the plutonium in the weapon component and forms plutonium hydride, which falls as a powder into the hot crucible below. The heat re-releases the hydrogen gas — the dehydriding reaction — and it escapes upward to the cold zone to react with more plutonium.

The recycle reaction with hydrogen gas continues until all the plutonium is recovered from the weapon component. The hydrogen is

then pumped out, to be reabsorbed into the uranium-hydride bed. Plutonium collected in the bottom of the crucible — 99.9 percent of the weapon's total — is melted into ingots that can be placed in hermetically sealed containers for long-term storage.

The entire process is contained within a 36-square-foot glove box. No hazardous materials are released to the environment, and worker exposure to radiation is significantly reduced.

Most importantly, this new dismantlement technology makes it possible to remove weapons from the nuclear stockpile permanently. Components attractive to terrorists and proliferant countries don't linger in the stockpile, and plutonium is reduced to a form that offers easy inspection and proof of compliance with disarmament treaties without disclosing sensitive weapon-design information.

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R&D 100

HIPPI-SONET GATEWAY

LINKS SUPERCOMPUTING CENTERS VIA COMMERCIAL TELECOMMUNICATION CARRIERS

The HIPPI-SONET Gateway forms data-transfer networks that link distant supercomputing centers at incredibly fast rates. Using commercial fiber-optic lines, the Gateway creates networks that can send the equivalent of a hundred 250-page books across the country in a second.

The Los Alamos Gateway allows researchers to assign different parts of tough problems to the machines best able to run the complex codes. Like a giant brain, these multi-located "metacomputers" can tackle problems such as modeling global climate change that would take too long at a single facility.

With the HIPPI-SONET Gateway, widely separated supercomputing centers can work together to address problems of worldwide significance.

←

In another application, these high-speed networks could be used as cross-country "backbones" to carry data from many differ-

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HIPPI-SONET Gateway developers Wally St. John (left) and David Dubois.

ent sources — for example, the rapidly growing number of people using the Internet.

The High-Performance Parallel Interface, or HIPPI, is an American National Standards Institute criterion conceived at Los Alamos and developed by a Los Alamos-led team of researchers. Many different computer companies use the standard to support local networks at 800 million bits per second. But the standard is not intended to connect computers more than a few miles apart.

The HIPPI-SONET Gateway provides a bridge to the fiber-optic networks of commercial telecommunications carriers, enabling cross-country networking at HIPPI speeds. The Gateway's interface with commercial carriers is based on the Synchronous Optical Network, or SONET, another ANSI standard for carrying cross-country digital data and voice traffic.

The Los Alamos Gateway has linked supercomputing facilities at Los Alamos, the California Institute of Technology in Pasadena, National Aeronautics and Space Administration's Jet Propulsion Laboratory in Pasadena, and the San Diego Supercomputer Center.

The Gateway also has been tested in an experiment where SONET signals were sent through a satellite rather than fiber-optic lines. In a project supported by the Advanced Research Projects Agency, the Gateway successfully sent data to NASA's Advanced Communications Technology Satellite and back to a ground station. The Gateway, using this or similar satellites, could extend high-speed networks to remote locations that lack commercial fiber-optic lines.

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THE ÍNDIGO-830

MINIMALLY INVASIVE TREATMENT FOR ENLARGED PROSTATE

Noncancerous enlargement of the prostate gland, or benign prostate hyperplasia, affects more than half of all men past age 50. Symptoms increase with age, and about three-fourths of all men seek medical attention by the age of 75. Prostate gland enlargement can cause symptoms such as urinary hesitancy, incontinence, and bladder distention that, if left untreated, may lead to kidney dysfunction.

The Índigo-830, pictured at left, uses infrared laser energy to trim the excess tissue of noncancerous, enlarged prostate glands.

Los Alamos scientists, working with Índigo Medical Inc. of Palo Alto, Calif., have invented a new, non-surgical way to treat noncancerous prostate enlargement. The Índigo-830 combines a compact source of laser energy with a light-diffusing fiber-optic delivery needle that evenly heats excess prostate tissue in an accurately controlled manner. Following treatment, the body's natural immune response causes the prostate to shrink over a period of a few weeks.

In a manner similar to conducting a needle biopsy, the urologist inserts an endoscope through the urethra and threads the fiber needle through the endoscope and into the prostate gland. The laser light heats the tissue just enough to kill excess cells. It is carefully controlled to prevent hot spots that result in vaporizing or charring of tissue, which would impair the body's ability to re-absorb the dead cells.

Los Alamos researcher Tamara Johnson holds a whisker-thin fiber similar to that used in the Índigo-830. The fiber is attached to a diffusing needle and threaded through an endoscope previously inserted in the urethra. The needle allows the surgeon to direct infrared laser light to the site of the excess tissue.

Outpatient treatment with only local anesthesia takes about 30 minutes and convalescence is greatly reduced compared with the standard surgical treatment. The low-cost procedure preserves the urethra and eliminates most of the side effects associated with the surgical method.

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Clinical trials have been completed in Germany, and the Índigo-830 is sold commercially in Japan and several European countries. In the United States, Índigo has completed the initial phase of Food and Drug Administration trials and begun expanded phase-two trials.

(See the January 1995 *Dateline: Los Alamos* for a related article on the Índigo-830 technology.)

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ARS CHEMICAL FILL DETECTOR

RAPIDLY IDENTIFIES CHEMICALS IN SEALED CONTAINERS

Based on the acoustic vibrations of an object, this Los Alamos technology quickly and safely identifies the fill content of chemical weapons or other containers holding toxic substances. Traditional methods of verifying the contents of chemical munitions require drilling a hole into the container and extracting a sample of the fill for laboratory analysis. This method is time-consuming, has the potential to contaminate the environment, and can expose workers to nerve gas or other chemical agents.

←

Components of the ARS Chemical Fill Detector include a computer notepad, digital analyzer and synthesizer, and a pen. Two test munitions sit behind the components.

Acoustic Resonance Spectroscopy, or ARS, is a noninvasive system that uses a sensor head with two transducers, which attach magnetically to the container being tested.

One transducer induces minute vibrations in the container while the other transducer detects those resonance frequencies at which the

container naturally vibrates. The pattern of the vibrational frequencies is affected by the physical properties of the contents and can be used as an acoustic signature. The system matches these vibrational patterns with signatures in a library to identify the chemical fill. The entire procedure takes less than a minute and at no time is the operator exposed to the chemical contents of the container.

The instrument is a small, battery-powered unit that can be used in the field under adverse conditions.

An operator analyzes a container's contents with the ARS system.

Measuring the vibrational modes of objects is a well-established technology; however, the use of acoustic signatures to identify fill materials and the software algorithms that implement this identification put this instrument ahead of traditional technologies.

Originally developed with the Defense Nuclear Agency as a noninvasive inspection tool to verify compliance with treaties on chemical weapons destruction, the detector is suitable for any noninvasive identification of fill materials in sealed containers. The technique can be extended to quality-control applications where defective parts would have a different acoustic signature than their good counterparts. In addition, the technique holds promise for a wide range of applications, such as detecting salmonella in eggs or measuring intraocular pressure during eye exams.

(See the August 1995 *Dateline: Los Alamos* for a related article on the ARS chemical fill detector.)

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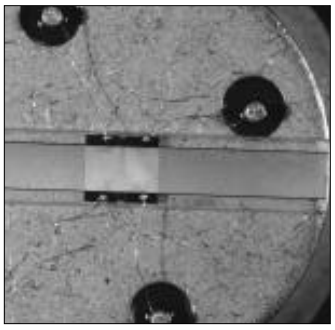
MICROSENSOR FOR VOLATILE ORGANIC COMPOUNDS

REAL-TIME, REVERSIBLE ENVIRONMENTAL MONITOR

Los Alamos' chemical microsensor is a radical departure from standard polymer film microsensors used by scientists and the chemical industry to detect volatile organic compounds. Polymer films absorb atmospheric gases and change color or electrical conductivity when they detect contaminants. But polymer sensors don't last long and can't easily pinpoint specific contaminants.



This photo of the microsensor shows the piezoelectric transducer (the horizontal bar) to which a thin-film organic sensing layer is attached.

Los Alamos' dime-sized microsensor consists of a sensing layer of molecules bonded directly to an electrical transducer that converts mechanical signals into electrical signals.

Tiny, cone-shaped molecules made of cyclodextrin, a component of starch, organize themselves along the transducer so that one end of each molecule attaches to the transducer and the other end extends as a "bucket" that can readily trap specific organic toxins.

When a contaminant fits into the bucket, the added mass of the trapped material causes changes in the transducer's electrical signal, which is picked up by a detector.

The cyclodextrin buckets hold the contaminants in a weak, temporary attachment — not in a chemical bond — and release them when contaminant concentrations are low, so the microsensor can be used repeatedly to monitor concentrations as they change over time.

The microsensor can be used to monitor air pollution wherever organic contaminants are released. Two examples are

Developers of the microsensor are (clockwise from upper left): Basil Swanson, Kendall Springer, JingXuan Shi, and DeQuan Li.

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monitoring air quality near gas stations and detecting organic contaminants in the stack emissions at production sites.

The unique Los Alamos method of attaching the molecular buckets directly to the detector means the sensing reaction occurs right at the interface between the detector and the environment. This allows chemists to build in, at the molecular level, favorable properties for specific contaminants. By changing the size and electrical polarity of the buckets, the microsensors can be customized to track specific organic toxins. Direct bonding also gives the microsensor long-term stability.

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POLYMER FILTRATION SYSTEM

RECOVERS AND RECYCLES ELECTROPLATING METALS

Los Alamos scientists and researchers from Boeing Defense and Space Group developed the Polymer Filtration System to recover zinc and nickel from electroplating rinse waters. The system can be applied to a wide range of other waste streams that contain metal contaminants.

In electroplating, an object is passed through a bath of metal ions that form a protective coating and then washed in a series of rinsing baths. Electroplating metals that remain in the rinse water typically are precipitated, collected, and buried as toxic sludge, which creates an environmental hazard and wastes valuable materials.

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Ultra-filtration membranes, shaped into hollow fibers, are revealed at the open end of an ultrafiltration cartridge.

Los Alamos' Polymer Filtration System minimizes electroplating waste by recovering the metal ions directly

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➔ Los Alamos researcher Thomas Robison with the mobile, light-weight polymer filtration system. Two key components are a water-soluble, metal-binding polymer, which is added to the unit's 5-gallon fluid reservoir on the left side of the cart and the two cylindrical ultrafiltration cartridges on the right side of the cart. Controls for monitoring and regulating pH, flow volume, back pressure, and conductivity are below the cart's top shelf.

and recycling them to the electroplating bath.

The process eliminates sludge byproducts and leaves the rinse water well within Environmental Protection Agency discharge limits. In many instances, discharge water meets drinking water standards for controlled metals.

The system has two elements: special, water-soluble polymers that bind selectively with metal ions, specifically zinc and nickel, and a compact pumping and ultrafiltration apparatus that puts the polymers in contact with the waste stream and performs the separation.

The polymers bind with metal ions in the liquid-waste stream, which then is pumped through a cartridge packed with ultrafiltration membranes shaped into hollow fibers. The metal-bound polymers are too large to pass through the filter, but water and simple salts pass through. A mobile pilot model of the polymer filtration system can process five gallons of waste water a minute. An industrial unit could process hundreds of gallons a minute.

More than 10,000 U.S. metal-finishing shops remove metals from their waste water with costly treatment techniques that often produce hazardous sludge. The polymer filtration system has the potential to prevent the formation of more than 50,000 tons of metal-containing sludge annually.

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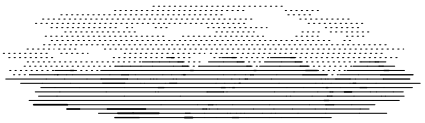

BRIEFLY ...

LOS ALAMOS TECHNOLOGY TRANSFER INFORMATION IS NOW ON-LINE. Los Alamos is leading construction of a nationwide computer network to inform private industry, academia, and government agencies about new technologies and research capabilities available for licensing from Department of Energy national laboratories. The DOE's Technology Information Network permits interested parties to look for specific technologies at individual laboratories or across the entire DOE complex. To access DTIN, a user needs a personal computer with an Internet link and a World Wide Web browser such as MOSAIC, NetScape, or MacWeb. Users can reach DTIN at http://www.dtin.doe.gov or by accessing the Los Alamos National Laboratory home page.

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