R&D
Research & Development

R&D 100 Awards Recognition Ceremony

June 2004

Los Alamos
NATIONAL LABORATORY
EST. 1943

R&D 100 Awards Recognition Ceremony

Thursday, June 24, 2004
Bradbury Science Museum
Los Alamos, New Mexico

Los Alamos
NATIONAL LABORATORY
EST. 1943

From the Director

The recognition Los Alamos National Laboratory receives through its participation in *R&D Magazine's* annual, international, R&D 100 Awards competition calls attention to the broad scope of achievements the Laboratory contributes to technological innovation in this country and, indeed, the world. Our discoveries in science and the applications that result play an important role in shaping the future of our nation. When we transfer our inventions and technological advances from the Laboratory to the private sector for commercial development, we strengthen the nation's economic security by enhancing our industrial competitiveness.

I commend our researchers for the diligence and creativity they have applied to developing the technologies submitted to this year's competition. I am pleased with the diversity of applications, which include biological software, high-performance networking, chem/bio detection, nanocomposites, and fuel cells.

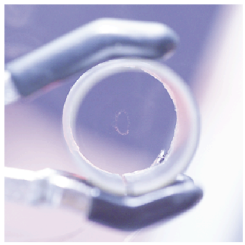
I believe every submission represented here is a winner for the Laboratory, the University, and the American taxpayers.

G. Peter Nanos, Jr.
Laboratory Director

The R&D 100 Awards

For the past 26 years, Los Alamos National Laboratory has submitted descriptions of its most innovative technologies to *R&D Magazine's* annual R&D 100 Awards competition. This competition is designed to honor significant commercial promise in products, materials, or processes developed by the international research and development community. Technologies are nominated in open competition and judged by technical experts selected by the Illinois-based *R&D Magazine*. The magazine uses technical criteria to select the 100 most significant, unique, or promising entries from the nominations received. According to the selection panel, "The sole criterion for making the grade is demonstrable 'technological significance' compared with competing products and technologies. Issues such as smaller size, faster speed, greater efficiency, and higher environmental consciousness have continued to gain importance in successful award submissions."

Los Alamos has been competing successfully for more than two decades with many of its winning technologies developed in collaboration with private-sector companies and other scientific institutions. The Laboratory won eight awards in 2003 and has received 89 awards since it began competing in 1978.



Los Alamos
National Laboratory
Greg Kaduchak
Dipen Sinha
Chris Kwiatkowski
David Lizon
Shulim Kogan

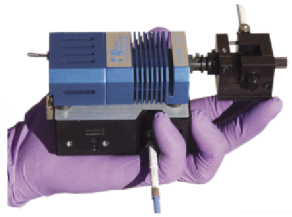
Aerosonic: Acoustic Concentrator of Aerosol Contaminants

Features

An inexpensive, low-maintenance, piezoelectric device, Aerosonic generates focused, resonance-based sound pressure to concentrate aerosols. The concentrated aerosols can then be directly isolated for analysis. Alternatively, when added as a front-end concentrator to existing low-sensitivity, hand-held detectors, Aerosonic increases detector sensitivity. Its light weight and low power consumption make it an ideal add-on. Functioning independently as a "filterless" filter, Aerosonic can—by removing the concentrated material—eliminate such air pollutants as diesel-engine combustion particulates, toxic byproducts from restaurant-kitchen exhaust, and airborne bacteria in hospitals.

Applications

- Facility Safety: Front-end sensitivity enhancer for hand-held detectors such as optical classifiers and particle sizers
- Air-Pollution Control: "Filterless" filter for diesel-exhaust particulates, combustion exhaust from restaurant kitchens, and airborne bacteria in hospitals
- Homeland Security: Concentrator for aerosol chemotoxins and biotoxins to facilitate their analysis



Los Alamos
National Laboratory
T. Mark McCleskey
Deborah Ehler
Gavin Collis
Edel Minogue
Anthony Burrell
Kevin John

Be Safe: Assay for Rapid Environmental Beryllium Detection

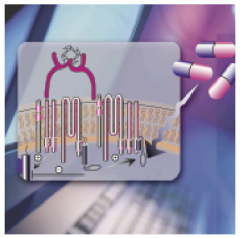
Features

A 30-minute assay for the presence of workplace beryllium, Be-Safe provides an unambiguous method for assessing the health and safety risks of workers from exposure to the toxic metal. With chronic, degenerative lung disease the potential consequence of even a small and transient exposure to beryllium particles, a fast, accurate detection assay is needed for industries that use beryllium in manufacturing products such as electronics, sporting goods, tools, jewelry, and dental apparatus. Be-Safe provides a convenient and inexpensive method for frequent and reliable workplace testing, thereby promoting prompt remediation and preventive measures.

Applications

Workplace beryllium detection in the following:

- Department of Energy complex, where beryllium is widely used in weapons manufacture and maintenance
- Manufacturing environments producing electronics, sporting goods, tools, jewelry, and dental apparatus
- Aerospace industry and other R&D environments in which beryllium and its alloys are used in development of new electrical and mechanical components



Los Alamos
National Laboratory
Michael Blinov
William Hlavacek
James Faeder

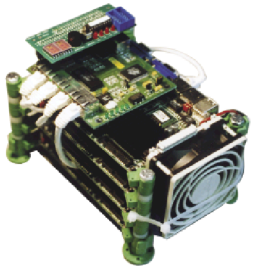
BioNetGen: Software for Modeling Biological Signaling Complexity

Features

BioNetGen is a software package that creates precise and comprehensive models for a wide array of biological regulatory systems, which often cause disease when they function abnormally. These models facilitate the design of more-focused experiments to test actual cellular signaling configurations (i.e., molecular species and reactions) and to evaluate the therapeutic potential—and potential side effects—of candidate drugs and drug targets inside cells. With its modeling flexibility, the software narrows the field for drug targets and defines what are potentially the most useful drugs, thus promoting the development of novel drugs and helping to reduce R&D costs in the pharmaceutical industry.

Applications

- Predicting the possible and probable signaling configurations in various cell types (guides experimenters in designing the potentially most informative protocols)
- Analyzing the molecular forms and complexes that arise within the dynamics of signaling reactions
- Identifying promising strategies for drug intervention, thereby directing design initiatives for drug synthesis
- Evaluating the probable effects on signaling of candidate drugs that act inside cells—before animal or human testing



Los Alamos
National Laboratory
Ron Minnich
Erik Hendriks
Sung-Eun Choi
Greg Watson
Matt Scottile
Li-Ta Lo
Adam Sulmicki

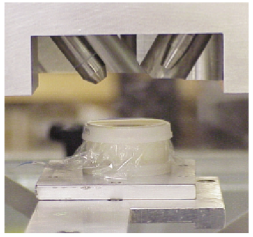
Clustermatic

Features

Originally designed as a low-cost version of a supercomputer, a computer cluster consists of a group of connected computers that work together as one. Unfortunately, setting up and managing such clusters is tedious and prone to mistakes, thus making clusters much more difficult to use than supercomputers. To address this problem, we developed the Clustermatic software suite. Clustermatic increases reliability and efficiency, decreases node autonomy, simplifies programming, reduces administration costs, and minimizes a user's reliance on unpredicatable software. As a result, Clustermatic enables commodity-based cluster networks to compete with their higher-cost and higher-profile supercomputer cousins by scaling to largest cluster configurations, providing predictive monitoring that reacts to mode failures, and creating a one-system view of an entire cluster.

Applications

- High-performance computing (HPC) applications include
  - nuclear weapons and other defense programs,
  - weather-pattern and climate simulation, forest-fire data gathering, and viral modeling.
- Applications related to LinuxBIOS include
  - motherboard manufacturing,
  - embedded systems (such as iRobot.com's PakBot), and
  - caching appliances for Web content, DVD players, and fiber-channel analyzers.



Los Alamos
National Laboratory
George J. Havrilla

XOS (X-Ray Optical
Systems, Inc.)
Ning Gao

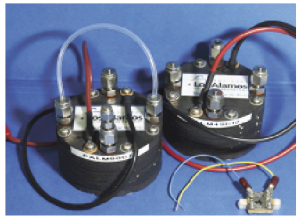
Confocal X-Ray Fluorescence Microscope

Features

Our microscope uses x-ray fluorescence to nondestructively measure the concentrations of elements within a tiny quasi-spherical "probe volume." The microscope moves the x-ray probe volume on or through an object to measure elemental concentrations on the object's surface, beneath a specific spot on the surface, or throughout the object's interior. The microscope measures the concentrations of a wide range of elements with parts-per-million sensitivity. It can analyze objects as thick as a few millimeters with a spatial resolution of 15 micrometers.

Applications

- Analysis of fine-art paintings, i.e., nondestructive studies of valuable paintings *in situ*
- Identification of elements present in radioactive waste for conversion to forms suitable for long-term storage
- Inspection of Space Shuttle thrusters
- Quality control of pharmaceuticals
- Characterization of new types of films for the semiconductor industry
- Analysis of crime scene evidence—enhances forensic information provided by other types of microscopes



DMFC-20 Portable Power System

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Ball Aerospace and
Technology Corporation
Jeffrey A. Schmidt
Bob Cook
Phil Hebner
Bob Kohl
Rodger Lucero
Tim Quakenbush
Larry Trubell
Bill Wildhaber

Features

The DMFC-20 is a compact, highly energy efficient, direct methanol fuel cell power system that is designed to deliver 20 watts of electric power for use in portable military applications. Portable devices are also in great demand in the civilian sector, and potential industrial partners are interested in moving the DMFC-20 to the commercial market. When operated for a month, the DMFC-20 can provide up to 10 times the energy density (or specific energy) of batteries. A lightweight, integrated methanol sensor ensures that the DMFC-20 operates with maximum fuel-conversion efficiency. The DMFC-20's high specific energy and very efficient fuel conversion distinguish our system from other direct methanol fuel cells.

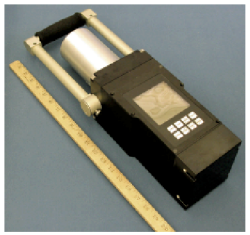
Applications

Commercial applications:

- Portable electronics
- Battery chargers
- household tools
- Long-operating air-quality sensors (e.g., carbon dioxide sensors)
- Remote road signs
- Camping equipment
- Electric scooters (hybrid systems with rechargeable battery)

Military applications:

- Auxiliary power
- Battery chargers
- Deployed field sensors



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GN-5: A Portable Gamma-Ray and Neutron Instrument

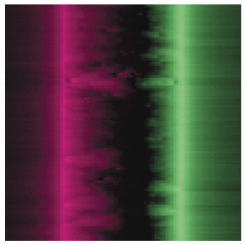
Features

GN-5 is a lightweight, robust, versatile instrument with the following key features: (1) detects gamma rays with high energy resolution using a high-purity germanium (HPGe) crystal; (2) uses a bismuth germinate (BGO) scintillator to suppress parasitic Compton signals that can obscure gamma rays; (3) compares gamma-ray signals with an extensive library of relevant gamma-ray energies; and (4) includes sophisticated electronics and software for accurate, real-time radioisotope identification with minimal user training. Operated alone, the BGO scintillator can be used to quickly scan containers for evidence of radioactivity. Once gamma rays are detected, the HPGe detector identifies the radioisotopes present. Comparison of the count rates from the two GN-5 neutron detectors (one shielded with cadmium) provides information about the possible presence of hydrogenous materials (e.g., explosives) in containers.

Applications

GN-5 can be used to detect smuggled nuclear and other dangerous materials or proliferation activities at many critical locations:

- Border crossings
- Harbors and airports
- Tunnels and bridges
- Office buildings, sports arenas, and convention centers
- Vulnerable installations, such as dams and power plants
- Facilities where nuclear-proliferation activities are suspected



Los Alamos
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Marilyn E. Hawley
Holger Grube
Geoff W. Brown
J. Yates Coulter
Dean E. Peterson

SuperPower, Inc.
Yi-Yuan Xie
Venkat Selvamanickam

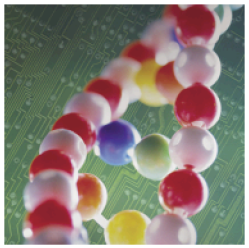
MIST: Magnetic Imaging of Superconducting Tape

Features

One of the stumbling blocks in manufacturing thin objects such as superconductors and miniscule objects such as computer chips is minimizing and perhaps even eliminating defects and imperfections. In many instances, defects and imperfections lead to less-than-stellar performance and even costly malfunctions. But how can one detect nanosized defects in objects that are so tiny to begin with? To address this problem, we have developed a combination of magnetic sensors and computer software known as MIST (Magnetic Imaging of Superconducting Tape) that noninvasively and nondestructively detects microscopic defects in superconducting tape and minuscule objects such as integrated circuits and other nanotechnological devices. For superconducting tape, MIST tests the fabricated tape for defects so that the manufacturing process can be adjusted to avoid producing "bad" coated conductors.

Applications

- Detecting microscopic and gross defects and imperfections in superconducting tapes likely to play an important role in generating and transmitting electrical power
- Testing currents in electronic and computer circuits
- Optimizing magnetic-hard-drive storage
- Enhancing quality-assurance/quality-control in the manufacture of nanosized objects



Los Alamos National Laboratory
Wu-chun Feng
Aaron E. Darling

mpiBLAST: A High-Speed Software Catalyst for Genetic Research

Features

BLAST, an open-source software package distributed by the National Center for Biotechnology Information, has become the ubiquitous genomic-sequencing tool in molecular biology. With mpiBLAST, our open-source parallelization of BLAST, we have dramatically enhanced BLAST's throughput and minimized its response time. The mpiBLAST software uses a new process known as *in-memory database segmentation*, in which a database is chopped into memory-sized pieces so that each compute node searches only a distinct portion of the database. When each portion has been searched, the message-passing interface (mpi) handles the communication to merge the results from each compute node. Thus, a search of a 300-kilobyte query that took 1,346 minutes (22.4 hours) using BLAST takes only a few minutes with mpiBLAST.

Applications

- Enables quick identification of previously unknown viruses, e.g., the SARS coronavirus, West Nile virus, and different strains of AIDS and cancer
- Accelerates complete genomic sequencing of organisms and drug discovery, reducing bioterrorism threats via pathogen detection and identification
- Contributes to other medical efforts, e.g., phylogenetic profiling and pairwise genome alignment
- Provides a more effective data-mining technique, e.g., technique could help identify and correlate intelligence and reconnaissance information and parallelize Internet search engines

Los Alamos National Laboratory
Quanxi Jia
T. Mark McCleskey
Anthony Burrell

PAD: Polymer-Assisted Deposition of Metal-Oxide Films

Features

PAD uses an organic polymer and one or more metal compounds dissolved in water to deposit high-quality films of nearly any metal oxide on nearly any shape or substrate. The organic polymer binds to the metal ions or complexes in the solution to prevent them from precipitating or forming other inorganic compounds. The result is a stable, homogeneous chemical solution that coats objects uniformly—an essential part of PAD's ability to form high-quality films.

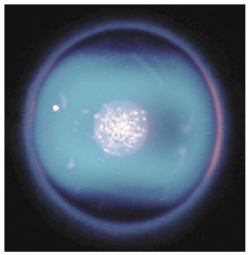
PAD produces higher-quality films with a greater range of chemical compositions than is possible with other chemical solution deposition techniques. Vacuum deposition techniques can also produce high-quality metal-oxide films. But because PAD does not require a vacuum system, PAD is easier and less expensive to use.

PAD can deposit amorphous, polycrystalline, or epitaxial films with thicknesses of 10 nanometers to hundreds of nanometers or more. The only requirement for the substrate is that it be stable in oxygen up to 400 degrees Celsius or slightly more. Metals, ceramics, glass, and silicon can be used as substrates.

Applications

PAD can be used to make films for

- flat-panel displays,
- microchips,
- solar cells, and
- superconducting tapes.



Los Alamos National Laboratory
Jonathan Phillips
Seth S. Gleiman
Chun-Ku Chen
(former LANL)

Plasma-Torch Production of Spherical Boron Nitride Particles

Features

Particles of heat-dissipation filler can be added to the resin packaging around an integrated circuit to improve thermal management. Crystalline boron nitride, with the highest thermal conductivity of any ceramic, would be the most effective filler material except that it naturally forms as irregular platelets. Only spheres have the right rheological (material flow) characteristics for semiconductor packaging tools and techniques. We have succeeded in melting crystalline (hexagonal) boron nitride by injecting the natural platelets into a hot (>3,500 kelvin) plasma, whose nitrogen-atom-rich environment stabilizes boron nitride, allowing it to be heated to its melting point. The particles melt, form spheres, and retain that shape when cooled. Ours is the first process to produce crystalline boron nitride spheres.

Applications

Our plasma-torch method produces a variety of materials:

- Spherical crystalline boron nitride for integrated-circuit packages
- Oxide spheres for integrated-circuit packages
- Carbon nanotube threads with the highest strength-to-weight ratio for ropes and other structures
- Photocatalysts for hydrogen generation and water purification
- Supported metal catalysts for crude-oil refinement, catalytic converters, and polymers
- Metallic and carbon-coated metallic nanoparticles as fuel components
- Oxide nanoparticles, possibly for next-generation armor

Los Alamos National Laboratory
James N. Albright
Donald S. Dreesen
David W. Anderson

Lithos Associates
James C. Thomson

Rocky Mountain Oilfield Test Center
Ralph Schulte

National Petroleum Technology Office, National Engineering Technology Laboratory
Rhonda Lindsey Jacobs

Stripper Microhole Technology

Features

Microhole technology is a paradigm shift for the drilling industry. It has the potential to allow much cheaper access to the remaining small pockets of oil in stripper fields (economically marginal fields that produce ~ 10 barrels of oil/well/day). In the past, 6- to 12-inch-diameter wells were necessary to support exploration as well as large-flow production during a well's commercial life. Drilling technology advances and progress in miniaturizing electronics and sensors have facilitated use of microholes (1-3/4 to 2-5/8 in. dia.) reducing oil recovery costs in shallow, economically marginal fields; increasing the number of accessible oil reserves; and reducing environmental damage. We proved to a skeptical industry that "it can be done." We integrated and adapted existing technologies into a drilling system that allowed construction of a 497-ft.-deep demonstration stripper microhole at the Teapot Dome oil field near Casper, WY, in September 2003.

Applications

- Reviving production in economically marginal oil and natural gas fields
- Exploring for shallow oil and gas at a greatly reduced cost
- Acquiring high-quality seismic data through the drilling of inexpensive holes to place sensors in an ultraquiet environment
- Monitoring primary and enhanced production processes for reservoir management
- Producing coalbed methane at remote locations

Los Alamos
National Laboratory
Jiang Qian
Yusheng Zhao

Superhard, Ultratough Nanocomposites

Features

Diamond is the material of choice for most abrasive applications because of its superhardness. Unfortunately, its use is limited because diamond is brittle and prone to fracture. We have solved the brittle-fracture problem by developing a novel nanostructured composite that consists of diamond particles embedded in a matrix of nanocrystalline silicon carbide. This nanostructured matrix halts the growth of cracks that lead to fracture. Our nanocomposites are the toughest, most durable diamond composites ever produced. They set a new performance standard for next-generation abrasives. In addition, our innovative synthesis technique can be extended to tailor the properties of other superhard materials.

Applications

Our diamond nanocomposites possess the performance-critical properties required to replace current tungsten carbide and diamond abrasives in a broad range of applications:

- Composite inserts for drilling bits in the oil and gas industry
- Super-abrasive components for high-impact mining, grinding, and cutting environments
- High-speed tool surfaces for machining nonferrous alloys and hard ceramics
- High-temperature dies for wire drawing
- Anvils for high-temperature, high-pressure materials research

Los Alamos
National Laboratory
Wu-chun Feng
Justin William Hurwitz

Intel Corporation
Matthew W. Baker

10-Gigabit Ethernet Adapter: Speed Really Changes Everything

Features

Have you ever tried to download a high-resolution graphic, movie, or video game from the Internet? Such downloads can take hours, and if you're lucky, your computer will not lock up, and the download will come through successfully. Now imagine that by installing a simple adapter into your computer, you could transfer information up to 148,000 times faster than a high-speed modem connection and up to 23,000 times faster than a DSL connection. This "super-adapter's" plug-and-play installation, reliability, and unprecedented speed will revolutionize how computers and the Internet positively impact our lives.

Applications

- Entertainment markets, e.g., video editing and animation, video- and music-on-demand, video games, and file-sharing applications like iTunes, Kazaa, Napster, and Gnutella
- Worldwide modeling and simulation markets, e.g., global weather and wildfire predictions, contagious disease communicability, galaxy formations and supernova explosions, financial market forecasting, and human genome sequencing
- Data acquisition and data mining markets, e.g., military intelligence and reconnaissance, basic-science research (fusion, bioinformatics, aerospace), and data warehousing
- Medical applications, e.g., interactive distance education (for patients and medical personnel), expedited patient care, and enhanced diagnostic imaging

Los Alamos National Laboratory R&D 100 Award Winners 1978–2003

1978
- Diamond Machining of Optics
- Electronic Identification System
- Electronic Device for Treating Tumors—Hyper Thermic Cancer Treatment

1980
- Wee Pocket Radiation Detector
- Portable Multichannel Analyzer

1981
- Radio Frequency Quadrapole Linac

1982
- WC Field Computer System

1983
- Transuranic Waste Assay System

1984
- Superconducting Magnetic Energy System

1985
- BHTP—A Unique Scintillation Compound

1986
- Aurora Laser Beam Alignment System

1988
- Optical Microrobot Single-Cell Manipulator/Analysis System
- Nuclear Material Solution Assay System
- 32-Stepper Motor Position Controller
- Mobile Beryllium Monitor
- HTMS Reference Electrode
- Oriented, Highly Anisotropic Conducting Polymer
- Photoinjector for RF Linac Accelerators
- Lattice Gas Algorithm

1989
- Fourier Transform Flow Cytometer (FTCS-1)
- Noncontact Superconductor Screening
- Conductive Lattices

1990
- Coolahoop
- Universal Process for Fingerprint Detection
- Fast Agarose Gel Electrophoresis (FAGE)
- Solid-State NO_2 Sensor
- Upconversion Solid-State Laser
- A Broadband (ABB) Mw Absorption Spectrometer for Liquid Media
- MdS2/SC Composites (Molybdenum Disilicide/Silicon Carbide)

1991
- Semi-Insulator Detector
- Optical High-Acidity Detector
- Resonant Ultrasonic Inspection (RUI)
- Single Molecule Detector

1992
- Thermal Neutron Multiplicity Counter
- Plastic Laser Dye Rods
- Cryogenic Diamond Turning
- Portable Laser Spark Surface Mass Analyzer (PLASSMA)
- Zeeman Refractive Index Detector
- Animated Display of Inferred Tongue, Lip, and Jaw Movements During Speech

1993
- Selenium-Based Reagents for the Evaluation of Chiral Molecules
- Phase-Sensitive Flow Cytometry
- Ultrafast Infrared Spectometer
- Mini Elastic Backscatter Lidar

1994
- Ultrasensitive Ultrasonic Transducer
- Telemetric Heat Stress Monitor
- Optical Biopsy System
- Lattice Boltzmann Permeameter
- Directed Light Fabrication of Complex Metal Parts
- Bartas Iris Identification

1995
- The Indigo-830
- ARS Chemical Fill Detector
- Hydride-Dehydride Recycle Process
- HIPPI-SONET Gateway
- Microsensor for VOCs
- Polymer Filtration System

1996
- TRACER (Transportable Remote Analyzer for Characterization & Environmental Remediation)
- PLASMAX (Plasma Mechanical Cleaner for Silicon Wafers)

1997
- Falcon: Breakthrough Software for Simulating Oil Reservoirs
- Rapid Size Analysis of Individual DNA Fragments
- ASR Detect—Diagnostic Method for Analyzing Degrading Concrete
- Dry Wash
- Plasma Source Ion Implantation for Enhancing Materials Surfaces
- High Performance Storage

1998
- Cyrax™—Portable, 3-D Laser-Mapping and Imaging System
- Low-Smoke Pyrotechnics
- SOLVE—Creating 3-D Pictures of Protein Molecules from X-Ray Diffraction Spots
- Underground Radio

1999
- Acoustic Stirling Heat Engine
- Atmospheric Pressure Plasma Jet
- CHEMIN: A Miniaturized X-Ray Diffraction and X-Ray Fluorescence Instrument
- PREDICT—A New Approach to Process Development
- Real-Time, Puncture-Detecting, Self-Healing Materials
- REED-MD: A Computer Code for Predicting Dopant Density Profiles in Semiconductor Materials
- The Sulfur Resistant Oxymitter 4000™

2000
- ANDE: Advanced Nondestructive Evaluation System
- Electroexploded Metal Nanoparticles

2001
- Free-Space Quantum Cryptography
- SCORR—Supercritical CO_2 Resist Remover
- Tandem-Configured Solid-State Optical Limiter

2002
- GENIE: Evolving Feature-Extraction Algorithms for Image Analysis
- HDF5 – Hierarchical Data Format

2003
- CARISS: Integrated Elemental and Compositional Analysis
- BASIS: High-Confidence Biothreat Detection and Characterization
- FIRETEC: A Physics-Based Wildfire Model
- Flexible Superconducting Tape
- FlashCT™
- Green Destiny
- PowerFactoRE: A Suite of Reliability Engineering Tools for Optimizing the Manufacturing Process
- Super-Thermite Electric Matches

R&D 100 Awards Sponsorship

The Technology Transfer (TT) Division serves as the link for technology transfer and Laboratory collaborations with private industry, universities, government agencies, and other national laboratories. TT matches Laboratory scientific and technical talent, expertise, and facilities with research and development endeavors in external sectors for the advancement of national security, technological innovation, and economic competitiveness.

As part of our commitment to the transfer of technology beyond the Laboratory, TT coordinates Laboratory participation in the annual R&D 100 Awards competition. In collaboration with technical staff and a dedicated, professional publications team from the Information Management Division, TT submits the Laboratory's most innovative technologies to the R&D 100 review panel.

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For information about TT, visit us on the Web at: http://www.lanl.gov/partnerships