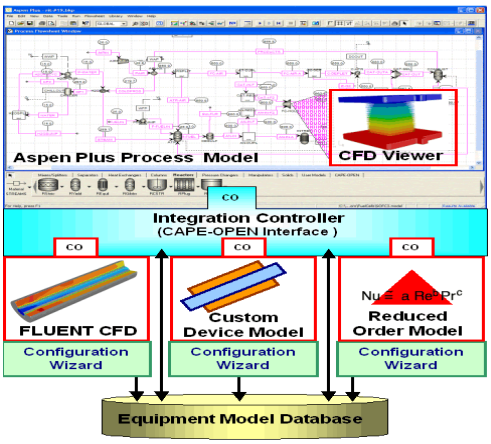
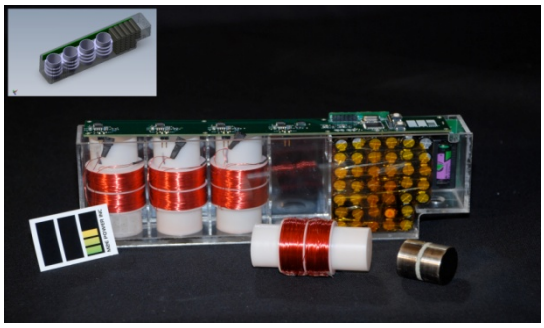
ENERGY

Energy Production:

The award-winning **Advanced Process Engineering Co-Simulator (APECS)**, developed at the National Energy Technology Laboratory, is software that allows engineers to optimize advanced power generation systems. APECS is in use by numerous purchasers, including Aspen Technology which has linked APECS with modeling and other software to optimize a solid oxide fuel cell auxiliary power unit. ALSTOM Power has used APECS to develop co-simulations of a conventional coal-fired, steam plan and an advanced natural gas-fired, combined cycle plant. APECS is a winner of a 2008 R&D 100 Award.



The **Motion to Energy Power Generation System**, developed at the Idaho National Laboratory with its licensee, M2E Power, Inc., coverts the power of motion into electrical generation and battery charging. It uses a micro-generator with power management circuitry that kinetically charges mobile batteries from natural motion, such as walking, eliminating the need for recharging and taking mobile devices off the electrical grid. Tests of the technology have shown that the battery life can be measured in years rather than the conventional hours or days. Originally developed for military use, it has many commercial applications in medical and electronic uses to large-scale hydro, wind, tidal and ocean wave and transportation power systems.

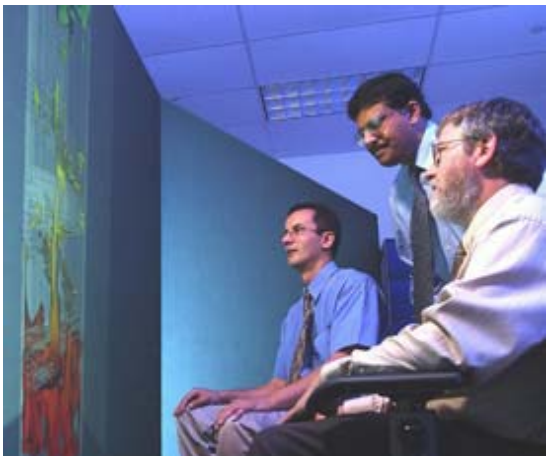


The award-winning **Thief Process for Mercury Capture**, developed at the National Energy Technology Laboratory, enables the cleaner use of coal for electricity production. The process uses partially-combusted coal from the furnace of a pulverized coal power plant as an in-situ sorbent to inexpensively remove mercury from flue gas emissions. The technology has been licensed to Nalco Mobotec, Inc., which is actively engaged in commercially developing and marketing the process. The Thief Process earned a 2009 Excellence in Technology Transfer Award from the Federal Laboratory Consortium for Technology Transfer (FLC).

The award-winning **Palladium-based Sorbent Technology**, developed at the National Energy Technology Laboratory, provides an efficient and economical method to remove mercury and other trace elements from the fuel gas produced in coal gasification. The technique is highly unique in that no commercial technology currently exists for removal of mercury and trace elements at the high temperature and pressure conditions within an integrated gasification combined-cycle (IGCC) system. Johnson Matthey Co. has exclusively licensed the technology, and is developing commercial palladium sorbent beds for industrial use. This technology won an R&D 100 Award and a Federal Laboratory Consortium Award for Excellence in Technology Transfer in 2008.

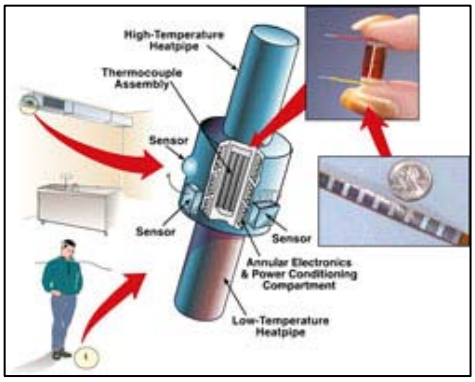
AUREX® 95P is a next-generation refractory material, engineered by the National Energy Technology Laboratory, to contain effectively the very harsh conditions created by the coal gasification process, providing the gasifier operator with up to 50% longer service life versus previously used refractory materials. This development of an improved refractory for air-cooled slagging gasifiers will translate directly to increases in system productivity, and as a result, will improve the viability of gasification as a zero-emissions technology for the production of chemicals and power. Harbison Walker Refractories Co. licensed the NETL patent and is commercially marketing the refractory material under the trade name AUREX® 95P.

The award-winning **Multiphase Flow with Interphase eXchange (MFIX) Software Package**, developed at the National Energy Technology Laboratory, enables scientists and engineers to reduce the time and cost of advanced energy technology development by evaluating innovations in design of systems such as coal and biomass gasification that capture and sequester carbon dioxide, by means of science-based simulations. NETL has applied the code in collaboration with Southern Company (SC) and Kellogg Brown & Root (KBR) to improve designs of advanced transport gasification systems. MFIX is made available to scientists world-wide through open-source code and is being applied to other fields such as volcanology. The MFIX software won an R&D 100 Award in 2007.



The Multiphase Flow Research Group in the Office of Research and Development at NETL develops capabilities to accurately model fossil power generation technology employing dense, reacting multiphase flow.

The award-winning **Continuum Coal Chemistry Module (C_3M)**, developed at the National Energy Technology Laboratory, allows scientists and engineers to accurately simulate chemical reactions in science-based simulations of advanced energy processes that use coal or other solid feedstocks such as biomass. C_3M can be used with NETL's MFIX code and the commercial Fluent code. C_3M was used to develop transport gasification with Southern Company (SC) and Kellogg Brown & Root (KBR). Arizona Public Service (APS) is using C_3M to develop the Advanced Hydrogasification Process (AHP). C_3M won a 2008 Excellence in Technology Transfer Award from the Federal Laboratory Consortium for Technology Transfer (FLC). This technology was recently licensed to ConocoPhillips.



The **Thermoelectric Ambient Energy Harvester**, developed at the Pacific Northwest National Laboratory and licensed to Perpetua Power Source Technologies, a start up formed to further develop and commercialize this technology, pulls power out of the environment at the exact location that it's needed. Using naturally occurring temperature differences to generate power from the surrounding environment means that a separate fuel source or batter is not required to run small, low-power devices such as wireless sensors and radio frequency transmitters. This is extremely useful where communication with a remote facility is necessary, such as monitoring the structural integrity of dams, buildings, bridges and pipelines, where access to sensor equipment for maintenance and repair is expensive and difficult. This technology eliminates the need for disposal of harmful chemicals present in conventional batteries, and provides for a longer lifespan as well.

The **Electro Optic Voltage Sensor System**, developed at the Idaho National Laboratory and licensed to OptiSense Network¸ can measure an electric field without actually touching it, allowing utilities to detect and locate a power failure before customers call to report it. The technology will enable utility companies to monitor feeder circuits more cost effectively, enhance system operations, optimize power flows, and provide greater grid security and reliability. Feedback from two major utilities indicates that the sensors reduce capital expenditure costs and real-time monitoring of the distribution grid by a 2% annual capital expenditure savings. Sales projections suggest that the licensee using the technology has the potential to contribute more than $80 million per year to its state economy and hopes to reach a larger audience in utilities that operate within voltages of 15 to 100 kilovolts – about 99% of utility companies.

Hydrogen:

The **Fiber Optic Hydrogen Sensor**, developed at the National Renewable Energy Laboratory and licensed to Nuclear Filter Technology, provides for early detection of hydrogen so vital to safe handling of hydrogen to support the market viability of a hydrogen-based economy. The hydrogen sensing market is a strong market with potential growth from its current size of about $800 million to an estimated $1.6 billion by 2010. The Fiber Optic Hydrogen Sensor has applications in industries that use or produce hydrogen including petrochemical, transportation, fuel cell applications, fuel production, food processing, natural gas and nuclear waste.

Batteries:

Solid Nanostructured Polymer Electrolyte for Rechargeable Lithium Batteries, developed at the Lawrence Berkeley National Laboratory and licensed to start-up company Seeo, Inc., is enabling development of a solid-state rechargeable lithium battery with the potential to improve the storage capability, safety and lifetime of rechargeable batteries for use in electric and hybrid vehicles, cell phones, laptops, and medical devices. In fact, batteries using this technology are expected to meet DOE's energy density goal for electric vehicles. These batteries are inherently safe because they lack the reactive and flammable materials of conventional lithium ion batteries, thus preventing thermal runaway. In addition, they resist dendrite growth, a factor that has stalled commercialization of rechargeable batteries.

Lithium Batteries, initially developed at the Lawrence Berkeley National Laboratory, were the basis for PolyPlus Battery Company, the Lab's first start-up, located in Berkeley, California and employing 27 people. PolyPlus Battery Company continues to develop innovations in high energy density lithium batteries and has built an impressive list of battery-related IP.

Geothermal:

Method for Mining Geothermal Waters, developed at the Lawrence Livermore National Laboratory and licensed to Simbol Mining, an entrepreneurial start-up formed to bring this technology to market, solves a critical problem of geothermal turbine facilities by extracting the silica that clogs pipes, filters and heat exchangers, enhancing geothermal plant efficiency. The recovered silica can then be used to supplement the short supply of silica for solar photovoltaic cells, and is also useful in other products such as paint, paper, toothpaste, tires and dehumidifiers. The technology is also useful in mining out other valuable minerals such as lithium used for electric car batteries, manganese, zinc and tungsten.

Solar:

Hybrid Solar Lighting, developed at the Oak Ridge National Laboratory and licensed to Sunlight Direct, LLC, is a lightweight, roof-mounted collector that concentrates visible sunlight

and blends the natural light with artificial light to maintain a constant level of room lighting, reducing the cost of lighting in commercial buildings and providing other benefits associated with natural lighting to the occupants of the building.

The award-winning **Nanocrystal Solar Cell,** developed at the Lawrence Berkeley National Laboratory, is an ultrathin film solar technology using nanocrystal semiconductors; it is the only photovoltaic technology that is sufficiently long-lasting and inexpensive to compete with electricity from the grid. It is licensed by Solexant, a start-up based in San Jose, California. The cell is a winner of a 2009 R&D 100 award.
Story link: Sunny Future for Nanocrystal Solar Cells

Advanced **Optical Furnace** technology for manufacturing thin-film silicon solar cells, developed at the National Renewable Energy Laboratory, has been recognized by Applied Optical Systems for its great potential in developing such solar cells with up to 15 to 18% higher efficiencies than presently available. This technology, which can be used to manufacture any type of solar cell, including diffusion, metallization and oxidation, will also make it possible to process a thin-film solar cell in only a few minutes, which reduces manufacturing costs. Under a cooperative research and development agreement, the Laboratory and Applied Optical Systems and have developed an optical furnace system prototype.

The award-winning **Inverted Metamorphic Multijunction (IMM) Solar Cell**, developed at the National Renewable Energy Laboratory and licensed to Emcore Corp., established a solar cell efficiency of 37.9% under concentrated light equal to 10 suns in 2005, and in 2008, a modified version of the IMM design set a new record of 40.8% efficiency under 326 suns. Under a cooperative research and development agreement, the Laboratory and Emcore Corp. are developing a commercial version aimed at the space satellite market and for use on Earth in concentrated photovoltaic arrays, which use lenses or mirrors to focus sunlight onto the solar cells. The cell is a winner of a 2008 R&D 100 award.
Story link: Photovoltaics Innovations Win 2 R&D 100 Awards

ENABLE technology, developed at the Los Alamos National Laboratory and licensed to Rose Street Labs Energy, Inc., is an energetic neutral atom beam used to synthesize high quality thin films critical to the development of full spectrum photovoltaics. The Laboratory and Rose Street Labs are collaborating to further the technology's excellent control of material composition, combined with high deposition rates, to improve performance and lower costs of full spectrum, multi-junction solar cell technology." ENABLE was a winner of a 2006 R&D 100 Award.

Energy-efficient Building Systems:

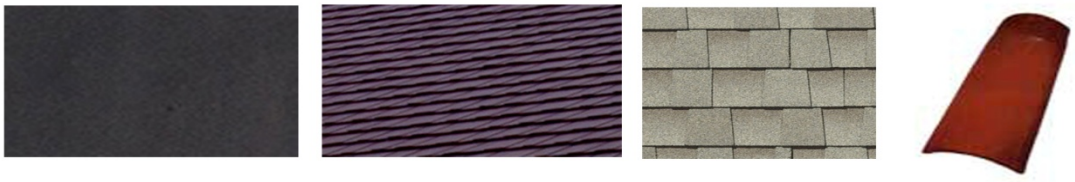
EnergyPlus, developed at and distributed by the Lawrence Berkeley National Laboratory is a building energy simulation software program that evaluates HVAC, lighting and window systems as well as natural ventilation in building plans to identify energy-saving design changes. When applied to the design of a new federal building in San Francisco, EnergyPlus saved $1.5 million in construction costs and is expected to save nearly $9 million in energy costs over 20 years. As of September 2007, he Lab had issued over 27 commercial distribution licenses for EnergyPlus and over 55,000 architects, engineers and students had downloaded the software.
Product link: A New-Generation Building Energy Simulation Program
Story link: EnergyPlus Saves Federal Building $9 Million in Energy Costs

Windows with Low-E (low-emissivity) Coatings are energy-efficient windows developed by the Lawrence Berkeley National Laboratory in response to the energy crisis of the late 1970s. They now represent more than half of all windows sold in the U.S. each year, and most new homes have them. The windows' glazing lets in visible light and minimizes the radiation load from sunlight, which reduces the energy demand for air conditioning.
Story link: Seeing Windows Through

Integrated Heat Pump Water Heater technology led by the Oak Ridge National Laboratory, Tiax and ECR International serves as the basis for the **ENERGY STAR** heat pump water heater criteria at the heart of these devices that are much like a refrigerator working in reverse, using liquid refrigerant to take the heat from surrounding air and transfer it to water in an enclosed tank. It is one of five water heating technologies that are eligible to earn the **ENERGY STAR** label which is expected to save U.S. consumers $823 million in utility costs, avoid 4.2 million tons of carbon dioxide emissions and achieve cumulative energy savings of more than 3.9 billion kilowatt-hours and 270 million therms of natural gas – enough energy to power more than 375,000 homes for a year.

Duct Sealing, developed at the Lawrence Berkeley National Laboratory has been shown to save up to 30% in annual utility bills by sealing air leaks in heating and cooling ducts in residential and commercial buildings. Carrier Corporation acquired a Berkeley Lab start-up in 2003 to increase the offering of this energy-saving product throughout the United States.
Story links: Aerosol-Based Duct Sealing Technology and Aerosol Duct Sealing.

Cool Color Roofs, developed at the Lawrence Berkeley National Laboratory with 16 industrial partners who have introduced or plan to introduce the products or components, is a toolkit for developing heat-reflective roofing products in any color using pigments that have a high ability to reflect solar radiation. This allows for making energy-saving roofing more widely available, potentially achieving a net energy savings in the U.S. worth over $400 million per year.



Left to right: American Rooftile Coatings, Custom-Bilt Metals, GAF/Elk, and MCA Clay Tile

Story link: Cool World: A Modest Proposal to Cool the Planet by Cooling the Neighborhood

Fossil Fuel:

The **Chevron/Los Alamos Alliance for Advanced Energy Solutions** has nearly 20 diverse projects that include long-term, high-value, cutting-edge technologies in oil shale extraction, down-hole communications, subsea technologies, refining separations, and imaging and modeling. Three projects—Inficomm, a downhole wireless communications technology being commercialized through a startup business; an acoustic separation technology; and a process to reduce pressures in an annulus in deepwater—are in the final commercialization stage.

SECURITY

Ultra-wide Band System for Securing Cargo, developed at the Lawrence Livermore National Laboratory and licensed to SecureBox Corporation is a wireless, cost-effective, low-power reusable device installed within the sidewall of a cargo container to detect intrusions and report real-time data and tracking to a secure web site, resulting in zero false alarms and 100% probability of detection, including several unscheduled intrusions by dock personnel. Useful in monitoring the more than 200 million cargo containers used each year to transport 90% of the world's cargo on trains, ships and trucks. The Ultra-wide band system is a winner of a 2008 R&D 100 Award.

An **Early Warning Crisis Management System for Chemical Attacks,** developed at the Argonne National Laboratory and licensed to Smiths Detection provides accurate, early detection of chemical agents and toxic industrial chemicals and response capabilities in confined spaces within densely populated areas, such as in city buildings and urban transportation systems.

Foam-based decontamination, developed at Idaho National Laboratory and licensed to Environmental Alternatives, Inc. provides for non-destructive removal and decontamination of radionuclides from concrete and other surfaces without further contamination of soil or ground water in a manner that is safe for first responder use. Contrasted with decontamination carried out by destroying and hauling away buildings, recovery from the effects of an RDD is enormously enhanced by INL's cleaning technology.

Portable radiation detection, developed at Lawrence Livermore National Laboratory and licensed to AMETEK's Advanced Measurement Technology ORTEC Division provides a low-cost, digital system for quick, real-time identification of specific radiation sources used in nuclear fuels, allowing for quick and less intrusive differentiation between dangerous and safe materials with very little margin of error.
Product link: Ametek-Ortec: High-precision Radiation Detectors [120-KB PDF]

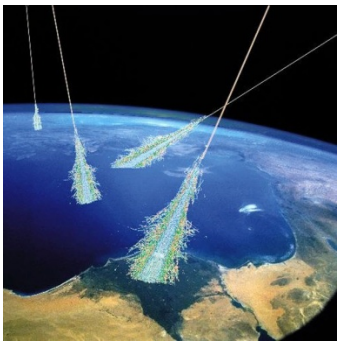
The award-winning **PhyloChip™**, developed at the Lawrence Berkeley National Laboratory and licensed to Second Genome (formerly PhyloTech), provides a rapid**,** accurate, comprehensive way of detecting the presence, quantity, and diversity of bacteria in an air, water, soil, or clinical sample without having to rely on inefficient bacterial culturing. This is useful in environmental situations, such as extensive flooding from hurricanes or the monitoring for presence of an airborne pathogen in the event of a suspected terrorist attack. The PhyloChip™ is the winner of a 2008 R&D 100 Award and the Wall Street Journal's 2008 Technology Innovation Award.
Product link: PhyloChip: DNA Microarray for Rapid Profiling of Microbial Populations

The award-winning **Antibody Profile Detection (AbP ID)**, developed at the Idaho National Laboratory, provides a low-cost, easy-to-use, accurate and rapid method for matching individuals

with forensic evidence by turning the individual antibody profile determined from very small samples of body fluids, such as blood, sweat or tears into a unique pattern. It can provide sample analysis results and comparisons in 2 to 5 hours, rather than conventional DNA testing that takes days or weeks to obtain results. It can also be used in security to confirm identities, as well as in agriculture for tracking animal products from the farm to the store shelf. AbP ID is the winner of an R&D 100 Award and an Idaho Innovation Award.

The award-winning **Easy Livermore Inspection Test Explosives (E.L.I.T.E**.), developed the by Lawrence Livermore National Laboratory and licensed to Field Forensics, Inc., is a small, easy-to-use, disposable detection tool designed for use by emergency response, law enforcement and military personnel to quickly and accurately locate small amounts of explosives. The E.L.I.T.E. is a self-contained, lightweight card with an indefinite shelf life ideal for use in the field. It has lower detection limits than other similar types of screening products and can detect 30 types of explosives and propellants. The E.L.I.T.E. is a winner of a 2006 R&D 100 Award.

Muon Tomography technology developed at Los Alamos National Laboratory to detect nuclear and other weapons of mass destruction will be made available by Decision Sciences Corporation to the Department of Homeland Security as effective tools to passively scan all cargo and vehicle traffic entering the U.S. This technology can be used with minimal disruption while providing accurate and rapid detection of concealed nuclear and explosive materials while reducing radiation exposure of existing scanning technologies.



The **Miniature Integrated Nuclear Detection System (MINDS)**, developed at Princeton Plasma Physics Laboratory is a cost-effective, compact system for detecting dangerous nuclear material, such as would be used in a dirty bomb or a nuclear device. It is small and can differentiate between threatening and non-threatening materials, significantly reducing false positives. MINDS has applications in transportation and site security, scanning of moving vehicles, luggage and cargo vessels, and at workplace entrances, post offices, tollbooths, airports, commercial shipping ports, and in police cruisers. It is currently in use at a U.S. military base, at a major rail and bus commuter center in the northeastern U.S. and a large company that provides security services to airports worldwide.

Millimeter Wave Holographic Body Scanner technology, developed at the Pacific Northwest National Laboratory and licensed to SafeView, Inc., now L-3 Communications, uses extremely low-powered millimeter waves – a class of non-ionizing radiation not harmful to humans – that penetrates clothing and reflects

off the body. The reflected signals are collected and sent to a computer where they form a high resolution 3D image in less than 10 seconds. It is useful for identifying anything on the body – metal, plastic, ceramic, and other non-metallic items that could be used as weapons. It is in use by the Transportation Security Administration in airport screening and worldwide at border crossings, and ferry landings.

Synthetic Aperature Radars (SARs), developed at Sandia National Laboratories, is an all-weather, day or night technique that provides key information unavailable through traditional optical means. It provides imagery and 3-D maps, can reveal minute changes in terrain, and be used for navigational guidance. Key technical advances have yielded a high-performance, ultra-fine resolution, all weather, day-or-night imaging capability that can be integrated onto small, low-cost airborne platforms as well as larger aircraft. MiniSAR filled a void in remote sensing technology by providing unequaled real-time image quality and resolution for tactical warfare systems, while achieving four- to five-fold reductions in size, weight and cost. In particular, it allows for seeing through smoke, dust, clouds and rain. These MiniSAR-derived systems have been engaged in a wide variety of missions, ranging from crevasse detection in Antarctica to incorporation in NASA's Lunar Reconnaissance Orbiter mission.

The **Handheld Advanced Nucleic Acid Analyzer (HANAA)** developed at the Lawrence Livermore National Laboratory is a portable, lightweight, battery-operated instrument that can rapidly detect and identify biowarfare agents. Smiths Detection developed the Bio-Seeq™ Plus instrument for fully portable polymerase chain reaction (PCR) identification of biowarfare agents for use by first responders and military personnel who are not trained biologists.
Story link: Smiths Detection: PCR Identification in the Field [81-KB PDF]

The award winning **Adaptable Radiation Area Monitoring (ARAM)** radiation detection hardware and software developed at the Lawrence Livermore National Laboratory uses a thallium-doped sodium iodide crystal for very low detection limits in near-real-time. Textron Corporation purchased Innovative Survivability Technologies (IST) which initially commercialized the ARAM system for border control security, installing many systems at border crossings. Textron continues to market the ARAM radiation detection system for homeland security applications in fixed portals, vehicle mounted mobile systems, man-portable backpacks, cargo planes, as well as aboard small watercraft. ARAM won a 2005 R&D 100 award.
Story link: Innovative Survivability Technologies: Detecting Radiation on the Move [379-KB PDF]

The **Mini-Raman Light Detection and Ranging Sensor**, developed at the Brookhaven National Laboratory is licensed to ITT Corporation for use in detection of chemical and biological agents.

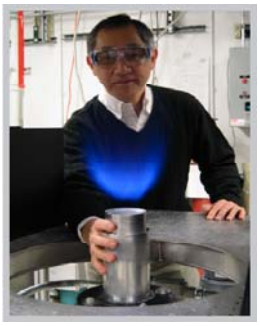
It is for use as part of the U.S. Government's early warning system against airborne attacks and for detection of chemical agents during battle.
Story link: BNL Scientists Patent Portable Sensor That Detects Harmful Substances, *the Bulletin* [379-KB PDF]

ENVIRONMENT

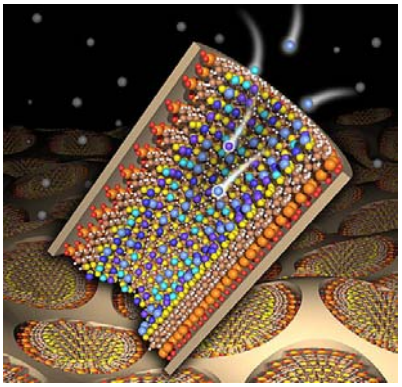
The award-winning **Metal Contaminates Removal Technology** developed at the Pacific Northwest National Laboratory quickly and easily reduces or removes mercury without creating hazardous waste or by-products, and that can be disposed of as a non-hazardous waste. SAMMS™, as it is known, is simple, inexpensive and easy to use. It has been licensed to Stewards Environmental Solutions LLC for treating gaseous emissions such as those that come from coals-fired power plants, and municipal incinerators. It also has been licensed to Perry Equipment Company for use in removing mercury from the water by-products of off-shore drilling and to remove mercury from crude oil. The technology received a 2006 R&D 100 Award and continues to garner international attention.

Shown is a SAMMS™, which forms effective sorbents for a wide variety of species including mercury, heavy metals, radionuclides and anions.

Combustion Technology developed at the Lawrence Berkeley National Laboratories is an ultra-low emission combustion technology for gas turbines that reduces greenhouse gas emissions and pollution to one-tenth that of state-of-the-art burners. The Low Swirl Injector defies conventional approaches, and has already hit the market in a product line of industrial burners sold by Maxon, Inc.



Customized Coating for Enhanced Water Sampling -- Functionalized Nanoporous Thin Films (FNTF), developed by Pacific Northwest National Laboratory is a low-cost, highly-selective means for detecting heavy metals in aqueous environments. The technology is used to coat the surface of silver-dollar-sized "sampler" discs, which provides the mechanism for increasing selectivity and detecting nearly every class of heavy metal that is harmful to human health. It provides



a testing means with an indefinite storage life without deterioration of the sample, enabling a reliable forensic archive. Coupled with X-ray fluorescence spectroscopy, this advancement gives water testers an easy-to-use technology that removes the requirement for complex chemical pre-treatment and handling of liquid samples needed for current heavy metal assay methods.

Environmentally friendly Plastics are a development from the metathesis method in organic synthesis, for which the 2005 Nobel Prize in Chemistry was awarded to a DOE Office of Science-supported researcher. This method rearranges groups of atoms within molecules that results in a reduction in the number of hazardous byproducts in a chemical reaction, leading to clean and environmentally friendly plastics.

CO_2 Scrubber process, developed at the National Energy Technology Laboratory and licensed to Powerspan, captures carbon dioxide from flue gas produced at power generation systems that use coal, by using an aqueous-based scrubbing solution. This regenerable process uses an ammonia-based solution to remove acid gases, including carbon dioxide, sulfur dioxide and nitric oxides. As added benefit, fertilizer is produced in the process and the spent ammonia solution is regenerated and recycled to the scrubbing unit, minimizing cost. This new wet scrubbing technique provides a solution for mitigating global warming and for pollution control, while allowing cost-effective electricity generation.

A **Process for Disinfecting Water** developed at the Lawrence Berkeley National Laboratory uses ultraviolet light to quickly, safely, and inexpensively remove the viruses and bacteria that cause cholera, typhoid, dysentery, and other deadly diseases. The disinfecting unit is produced by start-up WaterHealth International, which licensed the technology. The unit, which weighs in at a manageable 15 pounds, can be powered by a car battery or a 60-watt solar cell. It can disinfect water at the rate of four gallons per minute for a cost of about 30 cents per person per year.
Story links: Water Filter Could Help Millions of Bangladeshis and UV Waterworks: Purifying Water and Saving Lives around the World

Seismic Analysis Code (SAC) developed at the Lawrence Livermore National Laboratory is software designed for the study of seismic events, specifically sequential signals and time series data. SAC's emphasis is on analysis tools most desired by research seismologists for detailed analyses. IRIS (Incorporated Research Institutions for Seismology) is a university research consortium dedicated to exploring the Earth's interior through the collection and distribution of seismographic data. IRIS licensed the SAC software for their members and has distributed it to more than 2,000 scientists since 2005.
Product link: LLNL Tech Transfer Industrial Partnerships Office (IPO), Seismic Analysis Code (SAC)

The **Clamshell Closure for Metal Drums** technology was developed at the Savannah River National Laboratory. It is licensed to NucFil, LLC, a company interested in providing the

technology as part of a packaging design with a stainless steel drum to transport and store nuclear materials. The technology was originally designed to address DOE requirements for improved packaging for shipment of radioactive materials.

The **RadRope™ Portable Nuclear Material Detection System**, developed at the Savannah River National Laboratory, is a lightweight, portable system for rapidly detecting the presence of nuclear materials in sealed containers, without the use of harmful x-rays. It is exclusively licensed through UTEK Corporation, and their wholly owned subsidiary, Nuclear Materials Detection Technologies, Inc. It is anticipated that the technology will be used in a variety of configurations for both sea going cargo containers and airfreight. The technology was presented at World's Best Technologies Showcase in 2006 and was named one of the top 25 entries for 2006. Additionally, the technology received a Federal Laboratory Consortium, Southeast Region Award for Excellence in Technology Transfer in 2007.

Analysis of Large Soil Samples for Actinides, developed at Savannah River National Laboratory, has been licensed to Eichrom Technologies, Inc. This technology involves a method for separating and analyzing actinides in relatively large soil samples. Eichrom is a manufacturer of laboratory research and development products, specializing in highly selective ion exchange and extraction chromatographic resins for analytical and process scale applications.

Improvements to a Rotary Microfilter System, developed at Savannah River National Laboratory, have been licensed to SpinTek Filtration, Inc., a manufacturer of waste separation, filtration, and reverse osmosis equipment. The improvements simplify the ability to clean and maintain the filter.

The **Drum Plug Piercing and Sampling Device**, developed at Savannah River National Laboratory, and licensed to UltraTech International, Inc., allows gas samples to be taken from 55 gallon drums without placing workers at risk or damaging the drum. UltraTech is a manufacturer of waste storage equipment, chemical refuse disposal equipment, radioactive waste equipment, and emergency repair tourniquets for leaking drums and tanks.

Pro-Tec Tear Offs™ technology developed at Savannah River National Laboratory and licensed to Premier Technology, Inc., involves the application of multiple layers of transparent film to laboratory glove boxes and hoods to protect the surfaces from premature corrosion and wear. The technology was recognized with a 2007 Federal Laboratory Consortium, Southeast Region Award for Excellence in Technology Transfer.

Portable Liquid Collection Electrostatic Precipitator (ALPES™), developed at Savannah River National Laboratory and licensed to Analytical Reference Materials International (ARMI), is an easy-to-operate, highly efficient, lightweight, portable device that collects airborne particles and concentrates them into a liquid sample for scientific analysis, either on site or in a laboratory. The technology received an R&D 100 Award in 2003.

Surfactant Biocatalyst for Remediation of Recalcitrant Organics and Heavy Metals (BioTiger™) technology, developed at Savannah River National Laboratory, and licensed to Earthworks Environmental, Inc., is a biocatalyst comprised of a consortia of microbes that cleans up severely contaminated petroleum polluted sites. The technology was first used to remediate one of the three sludge lagoons on the site of the Czechowice oil refinery in Poland. BioTiger was presented at World's Best Technologies in 2006 and was selected as one of the 2008 NASA NanoTech 50 Award Winners.

Thixotropic Gel for Vadose Zone Remediation (VOS™) technology developed at Savannah River National Laboratory and licensed to EOS Remediation, LLC, Raleigh, is a new technique for remediation of the saturated zone between the land surface and the water table, known as the vadose zone. It employs sustainable green chemistry, including the use of vegetable oils. The technology can cost effectively turn land deemed unusable into productive and safe real estate. VOS fills a niche market for specialized technology for *in situ* anaerobic bioremediation of unsaturated soil.

Industrial Universal Electrometer, developed at Savannah River National Laboratory and licensed to Tegam, Inc., is used to measure the extremely low level current from Ion Chambers used in the SRS Tritium facilities.

ENDURE™ SCR Catalyst, developed at Los Alamos National Laboratory and licensed by Santa Fe-based CleanAIR Systems Inc., is a novel technology that virtually eliminates nitrogen oxides (NOx) from exhaust streams. CleanAIR is developing the technology for applications in stationary diesel and natural gas engines, pipeline compressors, and for on- and off-road equipment, and gas turbines.

The award-winning **SEQURE™ Well-Finding Technologies** developed at the National Energy Technology Laboratory deploy sensitive magnetic and methane sensors on helicopters to locate abandoned and leaking wells on very large tracts of land in a time and cost effective manner. Recently, the need to find and plug wells has become critical with the advent of carbon dioxide injection into geologic formations for enhanced oil recovery or carbon sequestration. NETL teamed with Fugro Airborne Surveys, LaSen, Inc. and Apogee Scientific, Inc., and others to develop and commercialize the technology. It is the winner of a 2007 R&D 100 award.

LIFE AND PHYSICAL SCIENCES

Micro-electro-mechanical systems (MEMS) Sensor Technology for Orthopedic Implants, developed at the Oak Ridge National Laboratory and the University of Tennessee, and licensed to Zimmer, Inc., enables accurate measurement of direct wear and force parameters that can be incorporated into research and clinical implants for continuous periodic wear and load assessment. It can incorporate different sensor types allowing monitoring of surrounding physiological parameters and is suitable for use with many different implant types including artificial knee, hip, shoulder, and elbow joints.

The award-winning **ElectroNeedle Biomedical Sensor Array**, developed at Sandia National Laboratories, has been licensed by New Mexico Biotech, Inc. and Life BioScience, Inc., both formed explicitly for commercialization of this technology. The ElectroNeedle provides rapid, on-demand, multiplexed, point-of-care biomedical assays for medical diagnosis in emergency, battlefield and remote settings, simply by pressing it against the skin, without need to extract body fluids. The ElectroNeedle is a winner of a 2007 R&D 100 Award.

The **Compact Scintimammography Gamma Camera,** developed at the Thomas Jefferson National Accelerator Facility in partnership with Johns Hopkins University, the University of Virginia, and Dilon Technologies, is in clinical trials to improve the early detection of breast cancer, especially in cases where standard x-ray mammography is not sufficiently sensitive.

Portable Acoustic Flow Cytometer, developed at the Argonne National Laboratory and licensed to Acoustic Cytometry Systems, LLC, a company spun off from Argonne National Laboratory in 2006, makes it possible for doctors or technicians to make diagnoses using a smaller, simpler, more rugged instrument that uses fewer consumables than previous systems, and generates minimal waste. It is the world's first portable acoustic cytometer, harnessing acoustic waves to focus cells into a tight, centered stream for analysis, resulting in less-expensive, greater throughput and sensitivity than conventional flow cytometers without the need for large volumes of purified water.

Medical Actinium for Therapeutic Treatment, developed at Idaho National Laboratory and licensed to NorthStar Nuclear Medicine separates actinium-225 from unused nuclear fuel, enabling its use as a medical isotope for targeted cancer treatment, while minimizing damage to surrounding normal cells. Idaho National Laboratory and Northstar have partnered in an effort to design and build a pilot plan to recover this medical isotope for this new cancer radiation treatment.

Materials Discovery Technology and Software, developed at the Lawrence Berkeley National Laboratory, is licensed to Symyx, a start-up that as of October 2009, employs 540 people. Symyx provides specialized technology and software to discover new materials more quickly and more inexpensively through combinatorial synthesis than through traditional trial-and-error processes. The technology speeds the advancement of breakthroughs in life sciences, chemical and energy-related products as well as consumer materials and products. Commercialized materials include new catalysts and polymers.
Story link: Start-Ups – Symyx Technologies, Inc.

Nanotechnology, developed at the Lawrence Berkeley National Laboratory and licensed by Nanomix, a company founded on the Lab's nanotechnology, provides ultra-sensitive, portable, low-power-use detection devices used in critical respiratory monitoring, biomolecule analysis and sensitive environmental monitoring applications.

Inorganic Nanostructures developed at the Lawrence Berkeley National Laboratory and further developed by Nanosys in collaboration with other industry partners for manufacture of products based on these high performance nanostructures. Nanosys has applied the technology in an array of industries to create products including lightweight, flexible solar cells and energy-saving LED-based lighting. Nanosys started on technology from the Lab and other leading universities.
Story link: New Hybrid Solar Cells Combine Nanotech with Plastics

Structure-based Drug Discovery developed at the Lawrence Berkeley National Laboratory and licensed by a start-up company, Syrrx, uses patented technologies to efficiently design viable new drug discoveries, primarily in the areas of metabolic diseases, cancer and inflammation. In 2005, Takeda Pharmaceuticals acquired the company, which continues to operate in California as Takeda San Diego, a Takeda global center for excellence in structure-based drug discovery. Multiple drug candidates discovered at TSD are currently in clinical trials, including a potential treatment for type II diabetes.

Breast Cancer Diagnostic developed at the Lawrence Berkeley National Laboratory and licensed by Novartis Vaccines and Diagnostics (Emeryville, California) involves a method of identifying the expression of a gene that appears to be a significant indicator of metastasis in breast cancer. Novartis intends to develop this technology into a diagnostic test to determine the likelihood of breast cancer to metastasize—information that could be used to determine if radical treatment, rather than more conservative radiation and chemotherapy, is required.

Parkinson's Disease Therapy developed at the Lawrence Berkeley National Laboratory and licensed by Genzyme Corporation is currently in Phase I/II clinical trials at UCSF. Over time, Parkinson's Disease patients lose the ability to convert L-dopa, the current therapy, to the needed dopamine. In this therapy, patients receive the gene coding for the missing essential enzyme that

converts L-dopa to dopamine. This gene therapy promises treatment of advanced cases of a disease that afflicts more than one million people in the United States alone.

Nano-Composite Arsenic Sorbent (N-CAS) developed at the Idaho National Laboratory and licensed to Water Technology Group Inc. will improve the ability to remove arsenic from contaminated water supplies and is seven times more effective than current arsenic removal technologies.

Water Sample Concentrator developed at the Idaho National Laboratory and licensed for further development and marketing by Teledyne Isco, is a new technology tool that will help in evaluating water supplies suspected of being contaminated by biohazards, chemicals, toxins, viruses, bacteria or potentially dangerous protozoa. A patent-pending technology developed jointly by U.S. Environmental Protection Agency's National Homeland Security Research Center in Cincinnati and Idaho National Laboratory, the Water Sample Concentrator integrates and automates collecting water samples, and the concentrating microorganisms in water, providing easy transport for field samples to a laboratory for testing.

The award winning **Laser Peening of Metals** developed at the Lawrence Livermore National Laboratory provides metals with greater resistance to fatigue and corrosion failures by using a high-energy, high repetition rate, short-pulse laser to repetitively fire at a metal surface. Metal Improvement Corporation (MIC), a subsidiary of Curtiss Wright, uses the laser peening process to extend significantly the service lifetime of aircraft engines, turbines in power generators, and other critical systems. MIC is also developing laser peening for precision metal forming. The laser peening process is an R&D 100 award winner.

The **Silicon-based Reaction Chamber** developed at Lawrence Livermore National Laboratory exhibits essential thermal properties that make it ideal for processing organic, inorganic, or biochemical reactions such as the polymerase chain reaction (PCR) and other DNA reactions. Cepheid has developed its core products around this technology, manufacturing and making available SmartCycler® and GeneXpert®, instruments which rapidly perform a broad range of genetic tests, from identifying infectious organisms to evaluating at-risk populations for the early detection of disease, at a reduced cost. Adaptation of the technology has allowed Cepheid to shift the paradigm of molecular diagnostics, automating otherwise manual laboratory procedures.

Chromosome Painting developed at Lawrence Livermore National Laboratory is a method for staining chromosomes to evaluate and manage certain genetic diseases allowing treatment customized to each patient's specific need. Abbott Molecular's line of Vysis products using chromosome painting include innovative genomic tests for chromosome changes associated with congential disorders and cancer. These include PathVysion® for monitoring breast cancer, UroVysion® for diagnosis of bladder cancer and AneuVysion® for detection of prenatal chromosomal abnormalities.

Magnetron Sputtering Source Design developed at Lawrence Livermore National Laboratory is used in vacuum deposition of thin films and allows for compactness, improved operating characteristics, greater versatility and lower fabrication costs. Using these sources, MeiVac, Inc. developed the MAK line of sputtering sources, noted for their innovative simplicity, ease of use and high reliability. It presents the smallest sputter head profile possible while delivering higher sputter deposition rates than comparable sputter sources. With more than 6,000 units delivered throughout the world, MeiVac is a leading supplier of sputter deposition sources, power supplies and substrate heaters.
Product link: MAK Sputter Source – Benefits

The award winning **Micro-impulse Radar (MIR)** developed at Lawrence Livermore National Laboratory is a low-power radar technology that uses ultra-wideband pulses. Transmission and reception are via carrierless, short duration pulses spread over GHz frequency and are therefore very difficult to detect and intercept. Licensees of LLNL's MIR patent portfolio have commercialized radar systems for automotive backup and liquid level sensing, bridge deck and roadway wear monitoring, search and rescue applications, wear monitoring of helicopter blades and rotors, cargo container intrusion sensing, perimeter security, and noninvasive medical diagnostics. Titan Logix Corp is a licensee that has developed the TD80 Dual Rod that measures liquid level and transmits the information to provide exceptionally safe, reliable and accurate level measurement and spill prevention in applications such as diesel transport. MIR application to liquid level measuring in an "Electronic Dipstick" won an R&D 100 award.

Cholesterol Testing to evaluate subclasses of low density lipoprotein (LDL) and high density lipoprotein (HDL), using a diagnostic developed at the Lawrence Berkeley National Laboratory, helps physicians provide a personalized approach for treating cardiovascular disease. Berkeley HeartLab, Inc, the start-up originally licensing the technology, was acquired by Celera in 2007 and is now operating as one of its subsidiaries.
Story links: Personalizing Cardiovascular Medicine and Low Density Lipoprotein (LDL) Assay for Cardiac Disease Risk

The award winning **Overnight Express™ Autoinduction System** developed at Brookhaven National Laboratory simplifies protein production in the widely used T7 gene expression system, also developed by the Brookhaven National Laboratory. The technology is licensed by EMD Biosciences, and commercially available as Novagen brand. The new system makes protein production automatic without intervention by the researcher. The Autoinduction System won a 2004 R&D 100 Award.
Story Link: William Studier of Biology Wins R&D 100 Award for New Method that Simplifies Protein Production, *the Bulletin*[253-KB PDF]

The award winning **Reactive Nanolaminate Materials** developed at the Lawrence Livermore National Laboratory are atomic-scale composites made from dozens of alternating layers of materials, with each layer just 0.2 to 200 nanometers thick. By carefully combining various elements and layer thicknesses, the nanolaminates can be designed to be extremely strong, highly reflective, unusually ductile, or exceptionally resistant to heat, wear, and corrosion. The reactive nanolaminate designs are energetic when activated by a mechanical force, electric charge or friction. Based on initial development of this technology, the licensee, Reactive Nanotechnologies (RNT) has continued to refine the process, now creating NanoFoil® and NanoBond® nanolaminates which are used as joining materials that can replace conventional soldering or brazing operations at lower costs than other soldering alternatives. NanoFoil can bond metals, ceramics, semiconductors and polymers on small assemblies or large industrial equipment. It can even bond dramatically dissimilar materials without causing the materials to crack. Reactive nanolaminate materials won a 2005 R&D 100 award.
Story link: Reactive NanoTechnologies Inc.: Temperature-Controlled Precision Bonding[88-KB PDF]

Every year, between 15 and 20 electronics manufacturers perform **Accelerated Testing of Chips and other Micro-electronic Equipment** using the neutron beam produced by the Los Alamos Neutron Science Center's (LANSCE's) Weapons Neutron Research (WNR) Facility. Cosmic rays interact with the earth's atmosphere, resulting in a shower of neutrons that interfere with electronics and cause disruptions such as glitches in output, changes of memory or register, or other damage to the device or the system. The high-energy neutron source at LANSCE generates energies similar in shape to the atmospheric neutron spectrum of cosmic rays, but with a much greater energy. As a result, testing a chip for an hour in LANSCE's neutron beam allows users to predict how that chip is likely to behave in the real world over a year of exposure to ambient atmospheric neutrons, thus enabling manufacturers to identify and correct weaknesses in their design early on in the production process.