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Lithium Titanium Oxide Spinel Anode System for High-Power Lithium-Ion Batteries

Department of Energy
Argonne National Laboratory



From left: Dr. Zonghai Chen, Dr. Khalil Amine and Dr. Ilias Belharouak

A team from Argonne National Laboratory developed and transferred a nanophased lithium titanium oxide (LTO) spinel anode system for use in high-power lithium-ion (Li-ion) batteries suited for hybrid electric vehicle (HEV) applications. The recipient of the transfer was EnerDel, the lithium-ion battery subsidiary of EnerI, Inc., an energy storage company headquartered in New York City. The innovation includes the novel anode material, system design features that permit the anode material to work well with the commercially available lithium manganese oxide spinel (LMO)-based cathode adopted by EnerDel, and a method for factory-scale manufacturing of the material.

The technology transfer process began when the Argonne team convinced EnerDel management to abandon its former business plan in favor of one that centered on HEV battery development. Essential for the transfer was the Argonne team's ability to meet EnerDel's commercialization goals within the unprecedented time span of only one year. The commercial realities facing EnerDel when it decided to work with Argonne were such that if it couldn't commercialize a Li-ion HEV battery within two years, it might as well not bother because current mar-

ket opportunities would evaporate as established HEV battery manufacturers would dominate the emerging marketplace with their own new Li-ion battery offerings. It was, therefore, absolutely essential for the transfer that the nominees and EnerDel produce a prototype battery within one year.

EnerDel is now negotiating to license a portfolio of battery technologies from Argonne, based on the success of this transfer. The technologies include the LTO spinel anode system, a battery chemistry suitable for plug-in HEVs, high-conductivity battery electrolytes and electrolyte additives, and a chemistry for batteries to be used

to store the energy received from solar and wind energy technologies. The result of the technology transfer process is the only lithium-ion battery for HEVs that meets or exceeds all of the requirements of the United States Advanced Battery Consortium—a battery that is unquestionably the safest, among the most reliable, the lowest cost Li-ion battery on the market, and the only one manufactured by an American company.

Argonne's LTO spinel anode system has enabled EnerDel to market highly reliable and extremely safe HEV batteries that are smaller in size and lighter in weight, provide more power and energy, and have a much longer life than the nickel-metal hydride batteries found in today's HEVs. Use of the new batteries will encourage HEV sales by eliminating the premium charged for these vehicles and by allowing consumers to receive an immediate return on their investment in terms of fuel cost savings, thus helping reduce America's dependence on foreign oil while slashing harmful emissions at the same time.

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Noninvasive Pneumothorax Detection

Department of Energy
Lawrence Livermore National Laboratory

Pneumothorax is a medical condition caused by air trapped in the space between the wall of the chest cavity and the lung. It often results in reduced lung capacity or collapsed lung. If not treated quickly, it could cause death in minutes. Definitive diagnosis requires a chest x-ray or a CT scan, but they are not available to emergency responders. Accurate diagnosis is particularly important if a patient is to be airlifted to a treatment facility because the drop in air pressure could exacerbate symptoms. There exists a strong need for a portable device that can diagnose pneumothorax quickly and in the field.

Developed by a team at the Lawrence Livermore National Laboratory (LLNL), the noninvasive pneumothorax detector uses ultrawideband (UWB) technology to diagnose this serious medical condition in seconds. The detector emits ultra-short radar pulses and captures return signals that are then digitized and stored in any computer.

Diffraction tomography software reconstructs cross-sectional images from these data and projects into a graphical user interface. This battery-operated device is ideal for trauma situations where low weight, low power consumption,

and insensitivity to acoustic and electromagnetic noise are critical. The device is so simple to use that patients at risk of developing pneumothorax following a surgical procedure can carry a detector to monitor their condition.

ElectroSonics Medical, Inc. (EMI) is a small business based in Cleveland, Ohio. Formerly known as BIOMECH, Inc., the company aims to accelerate the commercialization of medical device technologies through internal development and collaboration with major institutions and original equipment manufacturers (OEMs). The company has worked with LLNL to develop a prototype based on a handheld personal digital assistant (PDA) with a graphical user interface, and is pursuing an exclusive licensing arrangement with LLNL.

Progress is being made in moving the UWB technology to clinical validation, and it may be “tuned” to detect other life-threatening injuries. The handheld UWB device has the potential to become a multipurpose product that would be extremely valuable to emergency responders.



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Serial Technology Development and Transfer in Cargo Security

Department of Energy
Lawrence Livermore National Laboratory



Left to right: David Trombino, William Dunlop, Arden Dougan, Annemarie Meike, Carlos (Kique) Romero, and Peter Haugen. Dan Archer of Oak Ridge National Laboratory, Dirk Langeveld and Douglas Franco of SecureBox Corporation, Frank Swanson, Brian Adlawan of Textron Systems.

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The world transports more than 90% of its cargo by intermodal cargo containers. These shipments, currently numbering around 200 million, are vulnerable to damage, theft and other security breaches. National security experts identified the intermodal cargo container as a means to deliver a weapon of mass destruction to the U.S. heartland. In 2002, a team at Lawrence Livermore National Laboratory (LLNL) set out to understand cargo shipping vulnerabilities and find solutions. They examined maritime trade, including ocean shipping, transshipment points, off-loading, storage, and overland transport. As a consequence, the LLNL team identified key areas with improvement potential: internal cargo security, radiation detection, and active interrogation of special nuclear materials. They spotlighted the need to minimize the disruption of this monumental flow of goods and the consequent require-

ment of an ultra-low false alarm rate in any security device.

The team pursued internal cargo security and radiation detection, emphasizing tests in real-world scenarios with real end-users to identify, develop, field test, and mature a series of technologies targeted toward maritime applications with a low false alarm rate.

They added technical experts in radiation detection and ultra wideband (UWB), areas that have an extensive history of technical development at LLNL. As company partners joined the exercises to understand maritime environment needs and commercialize products, LLNL was able to provide business solutions for technology transfer. This maritime test bed connects developers, end-users, and licensees to develop and transfer technology.

Specific transfers include the Adaptable Radiation Area Monitor (ARAM) to Innovative Survivability Technologies (IST) and, ultimately, Textron Corporation. ARAM is a radiation spectrometer capable of distinguishing chemical signatures of normal and abnormal or unwanted radioactive materials at speeds of up to 50 miles per hour. The ARAM RadBoat became available in 2007. In addition, a cargo intrusion detector known as GUARDIAN was transferred to SecureBox Corporation. The SecureBox product is a low-cost, reliable, reusable, advanced cargo container security system. The device, which is based on UWB technology, reliably monitors containers throughout their voyage and detects intrusions through any of the container's six walls. SecureBox Rel. 1.0 was slated to become available in late 2008.

The United States continues to be a world leader in geothermal production of electricity. One problem in many geothermal turbine facilities is silica clogging the pipes, filters and heat exchangers. Yet the silica can be recovered and sold to manufacturers of products such as paint, paper, toothpaste, tires, or dehumidifiers. Also, such silica can be a source for the well-known shortage of silicon for solar photovoltaic cells. An energy company is often focused on power generation and views silica as a troublesome waste product, but technology at Lawrence Livermore National Laboratory (LLNL) can help not only solve the silica clogging problem, but mine out other valuable minerals such as lithium (electric car batteries), manganese, zinc and tungsten.

Over the last decade, a team of geochemists at LLNL has worked on research sponsored by the Department of Energy's Geothermal Program. More recently, they had support from the State of California's Energy Commission. The team took their lab work into the field at Mammoth Pacific L.P.'s geothermal power production near

Mammoth Lakes, California, to show how their combination of silica extraction process and reverse osmosis could help plant efficiency and result in extraction of valuable metals.

Meanwhile, a Houston-based entrepreneur heard about the LLNL team's work and optioned a patent for the silica extraction process. Later, the LLNL inventors left the laboratory and joined the company that the entrepreneur formed to bring this technology to the marketplace. The company, Simbol Mining, received \$6 million in venture investment and sited its new headquarters in the Livermore-Pleasanton Valley.

The successful transfer of the silica extraction geothermal mining technology is an inspirational green-tech endeavor. It not only can enhance geothermal plant efficiency, but aims to provide valuable commodity materials that would otherwise become a waste disposal problem. This is a beautiful combination of not only solving a problem, but in that process finding a hidden gold mine.



Left to right: Dr. Leah Rogers, Eddie Scott, and Cindy Atkins-Duffin of LLNL; and Dr. Bill Bourcier, Dr. Carol Bruton, and Luka Erceg of Simbol Mining

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Portable Acoustic Flow Cytometer

Department of Energy
Los Alamos National Laboratory



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The world's first portable acoustic cytometer (PAC) harnesses acoustic waves to focus cells into a tight, centered stream for analysis. The result is greater throughput and sensitivity than conventional flow cytometers without the need for large volumes of purified water and for thousands of dollars less.

Developed by researchers with the National Flow Cytometry Resource (NFCR) at Los Alamos National Laboratory (LANL), the PAC is one of

six R&D 100 Awards won by the flow cytometry team at LANL.

Conventional flow cytometers measure the physical and biochemical characteristics of cells, or any particle, and are standard diagnostic equipment in clinical laboratories and medical centers, where they produce blood cell and leukocyte subpopulation counts, and monitor levels of lymphocytes. A "sheath" fluid, usually a buffered saline solution, hydrodynamically focuses cells through a laser beam, requiring both additional fluidic control systems and the use of large quantities of purified water. Conventional equipment requires expensive light sources and detectors to adequately illuminate samples and ensure that enough scattered and emitted light is collected for analysis. The complexity of the fluidics system and the need for high-quality lasers and detectors make most commercial flow cytometers bulky, expensive, and fragile.

The PAC uses a single ultrasonically vibrated capillary in place of the complex fluidics system. Eliminating the sheath reduces instrument size and complexity, operating costs, use of consumables, and waste. This is particularly important in the field or in less-developed areas of the world,

where clean water can be a scarce and valuable commodity. The PAC will make it possible for doctors or technicians to make diagnoses using a smaller, simpler, more rugged instrument that uses fewer consumables and generates minimal waste.

In an effort to bring new particle analysis capabilities such as the PAC to clinicians and researchers worldwide, Acoustic Cytometry Systems (ACS), LLC, a company spun off from LANL, was founded in 2006 in Los Alamos to commercialize acoustic focusing technology in flow cytometry and sample preparation.

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Ammonia-based Scrubbing Process to Capture CO₂ from Power Generation

Department of Energy
National Energy Technology Laboratory

Over 50% of the electric power generated in the U.S. comes from coal-burning power generators. A major concern for power generation systems that use coal as an energy source is gaseous emissions from the plant. Although certain emissions are currently regulated, such as sulfur dioxide and nitric oxides, a very large potential exists that carbon dioxide (CO₂), a greenhouse gas, may be regulated in the not-too-distant future. It is suggested by the scientific community that global warming can be impacted by an increase in CO₂ concentration in the atmosphere.

Coal-burning power generators—new ones that may be constructed or the vast majority of older ones that will not be retired in the next 30 years—may need to adopt techniques to mitigate CO₂ emissions. Carbon sequestration, CO₂ capture followed by permanent storage, is a viable technology as outlined in the U.S. Department of Energy's (DOE) Fossil Energy Program. Patented, licensed, and transferred through a Cooperative Research and Development Agreement (CRADA) by the National Energy Technology Laboratory (NETL), this technology will aid in the mitigation of CO₂ emissions and provide the power generation industry with an af-

fordable and advantageous technique to capture CO₂ from power generation point sources.

For this technology, NETL researchers developed a novel process to capture CO₂ and other gaseous components from flue gas that are emitted from coal-fired power plants. The technology was transferred to Powerspan Corporation for commercialization. Based in Portsmouth, New Hampshire, Powerspan develops and commercializes proprietary, multi-pollutant control and CO₂ capture technology for electric power plants. The technology transfer activities with Powerspan included licensing of a patent that describes a technique to capture CO₂ from flue gas by using an aqueous-based scrubbing solution. Additionally, a Cooperative Research and Development Agreement (CRADA) between NETL and Powerspan was executed. The potential market for the technology is significant. When the technology is implemented, this new wet scrubbing technique will provide the utility industry—as well as the American public—with a solution for mitigating global warming and for pollution control, while also offering the ability to maintain electricity at affordable, reasonable prices.



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Thief Process for the Removal of Mercury from Flue Gas

Department of Energy
National Energy Technology Laboratory



From left to right: Dr. Evan Granite, Mark Freeman, William O'Dowd, Henry W. Pennline. Not pictured: Richard Hargis

Mercury is a toxic chemical element that has been linked to many health disorders in humans. Much of the mercury in the environment comes from the flue gas produced when coal is burned in electric utility boilers. Methods to reduce mercury emissions are thus of primary importance in protecting humans, wildlife, and the environment.

The “Thief Process,” developed by researchers at the National Energy Technology Laboratory (NETL), is a novel, low-cost method of removing mercury from flue gas from a coal-fired electric power generator. The process involves extracting a small portion of the partially burned coal from the combustion unit using a suction pipe called

a “thief” and injecting it in the flue gas downstream of the boiler. Here the partially burned coal acts like activated carbon to soak up mercury in the flue gas. In fact, activated carbon is currently transported to many power plants at great expense for just this purpose. The key to the Thief Process is that it greatly reduces mercury remediation costs by using a small portion of the coal already on hand—and actually in the combustion unit—instead of expensive activated carbon.

In 2005, the Environmental Protection Agency issued the Clean Air Mercury Rule (CAMR), which required reductions of as much as 70 percent in the mercury emitted by utility companies, with implementation of the rule beginning in 2010. Although CAMR has since been rescinded, many states have developed their own mercury emission regulations, and a new federal rule is likely to be drafted in the near future. In addition, the Canadian Council of Ministers of the Environment endorsed the “Canada-wide standards for Mercury Emissions from Coal-Fired Electric Power Generation Plants” in October 2006. These actions spurred Mobotec (now Nalco Mobotec), a world leader in multi-pollutant reduction, to seek a mercury remediation technology to add to

its already extensive product line. NETL licensed the Thief Process to Mobotec in May 2005.

Nalco Mobotec recently completed testing the technology in a commercial power plant at SaskPower, the principal supplier of electricity for Saskatchewan. The results of this commercial testing show that the Thief Process is a viable, low-cost mercury remediation technology that will enable the United States to continue to use its 250-year supply of coal to generate electricity. The estimated potential market for U.S. sales of the Thief Process is in excess of \$1 billion annually.

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Inverted, Metamorphic, Multijunction Solar Cell

Department of Energy
National Renewable Energy Laboratory

Developed by a team at the National Renewable Energy Laboratory (NREL), the “IMM”—or inverted metamorphic multijunction—solar cell is a new class of advanced solar cell. This technology has the highest efficiencies for converting sunlight into electrical energy.

The IMM cell’s primary function is to generate electrical power for both space applications and terrestrial use. The approach used leads not only to cells that exhibit extremely high efficiencies, but are also ultra-lightweight. These combined features give the IMM cell a high power-to-weight ratio—one that is a whopping 10 times higher than other current technologies. Equally important is the cell’s ultra-flexibility, a feature that is revolutionizing the design of solar energy arrays used to power space vehicles.

Transfer of the technology began in 2005 when companies involved in solar power for space applications immediately expressed a strong interest in acquiring the IMM. One company, Em-

core, entered into a Cooperative Research and Development Agreement (CRADA) with NREL that facilitated the transfer of NREL researchers’ unique and considerable know-how to Emcore. The transfer, in part, allowed Emcore to optimize the cell performance and prepare IMM cells for the manufacturing environment. Emcore also received funding from the Air Force Research Laboratory’s Space Vehicles Directorate to develop a better cell for space applications.

Because the IMM cell has all of the attributes highly desired for space power, it is on a fast track to commercialization, with production slated for 2010. This development process is also leading to its near-term use as an enabler of the emerging terrestrial concentrator photovoltaic (CPV) market. The more efficient and cost-effective the solar energy system, the more likely it is to succeed. A key environmental benefit will be the lowering of greenhouse gas emissions as fossil fuels used for electricity generation are displaced by the application of clean solar technologies.



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CF8C-Plus: New Cast Stainless Steel for High-Temperature Performance

Department of Energy
Oak Ridge National Laboratory



Dr. Philip Maziasz

Not pictured: Dr. D. Ray Johnson, Alexander DeTrana, Michael Pollard, Mort Sill

CF8C-Plus is a low-cost, high-performance cast stainless steel. Its development was driven by the need for more performance and reliability in high-temperature exhaust components for advanced diesel and industrial gas turbine applications. The technology—developed by a team at Oak Ridge National Laboratory (ORNL) with Caterpillar, Inc.—is seen as being able to bridge the gap between cast iron, steel, and nickel-based superalloys to provide cost-effective performance and reliability upgrades for many applications, including advanced diesel engine and industrial gas turbine combustor or support components.

Advanced diesels, which achieve higher fuel efficiency and lower emissions, push exhaust temperatures higher than what the current exhaust manifolds and turbocharger casings, which are made from cast iron, can withstand. Similarly, advanced industrial gas turbines, whose components are cast or wrought from stainless steel, are

being operated at increased exhaust temperatures for better efficiency and lower emissions; at those temperatures, the capabilities of the standard steels are exceeded. Both the diesel engine and gas turbine applications benefit tremendously from CF8C-Plus because it significantly improves high-temperature performance at similar cost. It has much more high-temperature strength and greater resistance to aging, fatigue, and thermal fatigue than standard or comparable premium grades of stainless steels and alloys.

Thus far, the CF8C-Plus units installed on Caterpillar diesel engines have generated about \$5.6 million in revenue, with a potential for a hundredfold revenue increase for future use in general automotive applications. In addition to its involvement with Caterpillar, ORNL is also partnering with Honeywell to test the technology for a turbocharger housing application. CF8C-Plus won an R&D 100 Award in 2003.

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SpaciMS: Spatially Resolved Capillary Inlet Mass Spectrometry

Department of Energy
Oak Ridge National Laboratory

Spatially Resolved Capillary Inlet Mass Spectrometry (SpaciMS), developed by a team at Oak Ridge National Laboratory (ORNL), is a technique for minimally invasive sampling of transient distributions of chemical species. The minimally invasive nature of SpaciMS allows measurements inside operating confined-space chemical reactors, such as the small channels of automotive catalysts, fuel reformers, or fuel cells.

Understanding the chemical kinetics of engines and operating reactor systems such as fuel cells, after-treatment devices, and fuel reformers is becoming increasingly important. The unique capillary sampling system of SpaciMS measures variations in chemical concentration from point to point within small systems (chemical reactors and engines) and provides near real-time results, thus making it a superior diagnostic tool.

Conventional analytical instruments measure only intake and exhaust composition and therefore do not capture the spatially and temporally rich chemistry within these systems. By resolving this detail, SpaciMS provides a new ability to

understand engine, reactor, and catalyst chemistry. Although originally developed to study diesel catalysts, SpaciMS has been applied to elucidate the chemistry in a broad range of technologies, including fuel reformers and fuel cells, fast engine transients (e.g., pulsed fuel-rich-lean operation), exhaust gas recirculation hardware performance, and engine intake uniformity.

The ORNL technology has been put to use to improve vehicle performance. For example, the SpaciMS was instrumental in launching the groundbreaking 2007 Dodge Ram heavy-duty pickup truck, which met 2010 emissions control standards three years early. As SpaciMS becomes more accessible commercially, it is expected that it will be applied in more systems and in novel ways.

SpaciMS was developed through Cooperative Research and Development Agreements with Cummins, Inc., and Queen's University, Belfast, Ireland, which developed a commercial time-of-flight SpaciMS device with Hiden Analytical. SpaciMS won an R&D 100 Award in 2008.



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Solid oxide fuel cells (SOFCs) have a number of advantages over other fuel cell technologies, including fuel flexibility, non-precious metal catalysts, and a high-quality waste heat. Research and development efforts, such as the Department of Energy's (DOE) Solid State Energy Conversion Alliance (SECA), are demonstrating that SOFCs are a critical component of our national strategy aimed at energy independence and environmental sustainability.

SOFCs can deliver substantially higher electrical conversion efficiencies when compared to traditional technologies such as internal combustion engines. Applications for SOFC technology range from sub-kilowatt (kW) military systems, multi-kW units for residential and mobile auxiliary power units (APUs), to large-scale megawatt (MW) hybrid systems operating on gasified coal.

To commercialize the SOFC technology, Pacific Northwest National Laboratory (PNNL) and Delphi Corporation teamed to develop an APU for vehicles such as long-haul trucks, military transports, and recreational vehicles. Prior

to teaming with Delphi, PNNL had developed several key technologies related to materials and fabrication processes for SOFC cells and stacks. These developments include a cell fabrication process for an anode-supported SOFC design, glass and braze seals, high temperature interconnects, and electrochemical and stack models. Through an innovative cross-license arrangement, Delphi integrated the PNNL technology with its own intellectual property in stack and system design, enabling the development of a highly efficient SOFC system.

The SOFC technology developed by PNNL and Delphi will play a critical role in improving energy-efficient power generation in a number of applications ranging from the aforementioned APU, to combined heat and power units for residential customers, to the development of large-scale clean-coal-fired power plants. By operating at higher electrical conversion efficiencies on reformed hydrocarbon fuels, SOFC technology can help ensure that finite fossil fuel resources are used efficiently and cleanly.



From left: Andrew Rosenblatt, Chris Coyle, Dean Paxton, Derek Maughan, Dr. Gary McVay, Dr. Jeffrey Stevenson, Dr. Jin Yong Kim, Dr. Joe Keller, Dr. Larry Chick, Dr. Scott Weil, Dr. Shubi Mukerjee, Dr. Vincent Sprenkle, Dr. Vladimir Korolev, Dr. Z. Gary Yang, Eric Mast, Gary Maupin, Jeff Bonnett, John Diebler, John Hardy, Karl Haltiner, Kerry Meinhardt, Kurtis Recknagle, Meg Soldat, Mike Davis, Nathan Canfield, Robert Silva, Russ Bosch, Steven Shaffer

Thermoelectric Ambient Energy Harvester

Department of Energy
Pacific Northwest National Laboratory

The Thermoelectric Ambient Energy Harvester technology pulls power out of the environment at the exact location it is needed to produce usable amounts of electric power to run small, low-power devices such as wireless sensors and radio frequency transmitters. This capability to use naturally occurring temperature differences to generate power from the surrounding environment means that a separate fuel source or battery is not required for the sensor to function. The technology is significantly longer-lived than batteries or other power sources. It reduces or eliminates the need for routine maintenance and service because it produces the necessary power throughout the life of the application.

This technology transfer effort began when Pacific Northwest National Laboratory's (PNNL) Technology Entrepreneurship Program participated in the University of Oregon's MBA program. A student team developed a successful business plan/market feasibility study for the Thermoelectric Ambient Energy Harvester that identified several promising uses for the technology. Subsequently, a new company was formed. Perpetua Power Source Technologies, based in Corvallis, Oregon, then negotiated with PNNL

to license the technology for applications in the wireless sensor field. An initial research license included an option for the development of a prototype for potential future commercialization. Following a very short development period, Perpetua was granted an innovative commercial license to manufacture and distribute its newly developed product based on the Thermoelectric Ambient Energy Harvester technology.

Specifically, this technology provides a more efficient and effective power source for applications where communication between the site of the application and 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/or repair is expensive and difficult. With this technology, the operating life and life-cycle costs of remote monitoring systems are no longer directly or indirectly dictated by the 5- to 10-year maximum lifespan of traditional batteries or other power sources, allowing for much more efficient use of operational resources. Less time and effort is spent accessing remote locations to check on and maintain sensor equipment. In addition, the cost savings realized when less travel is needed

and power sources are replaced less frequently is significant. Finally, by continuously generating energy from its natural environment, significant environmental benefits will accrue. The Energy Harvester technology's longer lifespan reduces the frequency of replacement and eliminates the need for disposing of the harmful chemicals present in batteries and other existing power source options.

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From left: Kenny Silber, Dana Mastrovito, Bill Davis, Steve Langish, Charles Gentile.

Researchers at the Princeton Plasma Physics Laboratory (PPPL) have developed a highly accurate and cost-effective nuclear detection system for antiterrorism applications.

Shortly after the terror attack of September 11, 2001, the Department of Energy (DOE) asked all of its laboratories to identify technologies for antiterrorism applications. Using mostly off-the-shelf components, Charles Gentile and his colleagues in the PPPL Tritium Group configured a small portable and relatively inexpensive system to identify and locate the radioactive element tritium that had been deposited throughout the Tokamak Fusion Test Reactor (TFTR) vacuum chamber. Charles Gentile and his team realized that this system, which they had developed for PPPL's fusion research effort, would be very useful for detecting and identifying specific radionuclides suitable for use in a radiological dispersive device (RDD), commonly known as a "dirty bomb."

The PPPL system known as MINDS (miniature integrated nuclear detection system) is very small compared to other systems and has the distinct

advantage of being able to differentiate between threatening and non-threatening materials, thereby significantly reducing false positives. MINDS has applications in transportation and site security, scanning moving vehicles, luggage, cargo vessels, and could be employed at workplace entrances, post offices, tollbooths, airports, commercial shipping ports, as well as in police cruisers, to detect the transportation of RDD nuclear materials.

The system has been transferred to a licensee, Insitech, Inc., a Partnership Intermediary representing the business interests of the Armament Research, Development, and Engineering Center (ARDEC) located at the U.S. Army's Picatinny Arsenal in Morris County, New Jersey. In turn, Insitech has sublicensed MINDS for use in a number of locations, including shipping containers at seaports.

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Novel Dendritic Platinum Catalysts for Fuel Cells

Department of Energy
Sandia National Laboratories

Renewable energy sources are of great interest today given the increasing costs and negative environmental impact associated with continued fossil fuel use. Hydrogen-powered fuel cells offer an attractive alternative to current technologies; however, more durable, efficient, and inexpensive fuel cell catalysts are required before fuel cells can be a practical and cost-effective solution to the growing energy crisis. One promising method of developing relatively inexpensive fuel cell catalysts is the use of high-quality platinum electrocatalysts that allow the size and shape of the platinum structure to be manipulated at the nanoscale.

Researchers at Sandia National Laboratories (SNL) have developed innovative methods of producing platinum catalysts that offer much greater control over the shape, size, porosity, composition, stability, and other functional properties of platinum nanostructures than those achieved by existing methods. These highly efficient, novel catalysts are expected to reduce the amount of platinum needed and thus reduce the cost of platinum catalysts for use in fuel cells, solar cells, and other applications in the renewable energy sector.

Compass Metals, Inc. has negotiated a license with SNL for the rights to ten patents to make, use, and sell these platinum catalysts in the

fuel cell area. Under a multi-year Cooperative Research and Development Agreement (CRADA), SNL and Compass Metals are also collaborating to further improve the synthesis of platinum nanomaterials in large-scale preparations to determine the best methods for incorporating these new nanomaterials in the fabrication of fuel cell electrodes and to discover new nanomaterials.

Ultimately, the advances achieved through this technology transfer effort will lead to improved energy security for the United States. Nanoscience, the study of matter at the atomic scale, offers new approaches to addressing U.S. energy security challenges through understanding and developing materials that exhibit novel and unprecedented functionality for energy production, storage, and use. By building structures one atom at a time, materials can be designed to have catalytic, electrical, or optical properties that can be applied to the specific economic and security needs of the nation.



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A team at the Thomas Jefferson National Accelerator Facility (Jefferson Lab) successfully developed and transferred a lifesaving medical imaging technology—compact gamma cameras for the improved detection of breast cancer. The gamma imaging technology was licensed to a high-tech startup company, Dilon Technologies, Inc., in Newport News, Virginia, and is commercially known as the Dilon 6800 Gamma Camera. The Jefferson Lab Radiation Detector and Medical Imaging Group, in addition to its principal role of researching detector solutions and technologies for experimental nuclear physics research, is developing application-specific gamma ray imaging detectors for breast cancer diagnostics and molecular biology medical-oriented research. This device is a direct spinoff of technology used in the nuclear physics mission of the Lab.

Breast-Specific Gamma Imaging (BSGI) is a molecular imaging technique that has proven to be an effective tool differentiating between malignant and benign tumors. Better than its predecessor, scintimammography, BSGI relies on the advanced imaging technology of anatomic-specific detectors to detect early-stage cancers. Prior to development of this specialized camera, the size and performance of large general purpose gamma

cameras used to perform scintimammography and other general nuclear medicine applications was not well-suited to imaging the breast.

Collaboration between Jefferson Lab, clinical sites, universities and Dilon helped move this concept from the lab to patients in need. Breast centers and hospitals across the country—and many international sites—are delivering advanced patient care because of the lab's work. The new BSGI camera based on Jefferson Lab's detector technology is particularly useful in patients with dense or fibrocystic breast tissue, and it has identified malignancies that were missed by conventional mammograms, resulting in improved treatment planning and outcomes.

Many technology transfer mechanisms such as Cooperative Research and Development Agreements (CRADAs), patents and licenses were utilized to develop this camera from an idea in a lab to an internationally recognized lifesaving medical device. The technology transfer efforts in developing the breast-specific gamma imager epitomize the way that basic research-driven technologies can find application and be developed and commercialized to make a significant difference in our daily lives.

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