

TECH TRANSFER

Success Stories

2010



*“Securing a Peaceful
and Free World
Through Technology”*



Sandia
National
Laboratories



innovation
through partnerships

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Sandia & AM Biotechnologies

RapiD_x

Background

RapiD_x is a prototype portable diagnostic instrument, based on lab-on-a-chip technologies, designed to rapidly measure toxins and disease biomarkers in human biological samples with high sensitivity for application in point-of-care (POC) clinical diagnostics. Sandia National Laboratories' first commercial partner on the RapiD_x system came in 2008 following a NASA SBIR grant award to AM Biotechnologies, whose "Thioaptamer Diagnostic System" will integrate the company's proprietary thioaptamers with Sandia's RapiD_x system. Through this collaboration, RapiD_x will be adapted to detect osteoporosis as well as other conditions that may impact astronauts as a result of space flight. This collaboration has entered into Phase II, in which the team will conduct trials with a prototype RapiD_x device.

Innovative Edge

Current diagnostic methods lack the sensitivity necessary to detect key low-abundance protein biomarkers present in bodily fluids. They are also too expensive to be used for a large-panel biomarker screen. The RapiD_x large panel biomarker screening platform represents a new paradigm in diagnostics where the focus will lie on preemptive, or very early stage, detection of disease rather than reactionary, postsymptomatic approaches. RapiD_x provides the advances necessary to create a large panel biomarker screen that is sensitive, rapid, and

cost effective while being available at the POC. RapiD_x is a self-contained, automated device that can rapidly measure up to 64 biomarkers at once using microliters of blood, saliva, or other

bodily fluids. RapiD_x can be used to detect sub-picomolar concentrations of biotoxins and infectious disease agents; oral or periodontal disease biomarkers; inflammation and immune response; and biomarkers for monitoring astronaut health. The flexibility of the immunoassay platform positions RapiD_x to impact early detection of other diseases including prostate

and other cancers, traumatic brain injury, and cardiac injury. As a commercial product, RapiD_x may be suitable for addressing national security issues such as screening of potential victims in a bioterrorism event or for rapid assessment of troops in a battle zone. For example, if a crowd is exposed to dangerous biotoxins, the exposed population can be rapidly triaged with RapiD_x for timely treatment—critical in such an event—while conserving valuable health resources and saving lives.

Commercialization & Industry Impact

Sandia plans to license its background intellectual property related to RapiD_x to AM Biotechnologies, so the company can manufacture commercial devices in its fields of use. In addition, Sandia is currently engaged in discussions with several other businesses that are interested in marketing RapiD_x for specific market applications.



Sandia & Boeing, Caltrans, and Others

Fuel Cell-Powered Mobile Lighting Applications

Background

Highway construction workers, airport maintenance personnel, and film crews use small, portable lighting systems known as “mobile lighting.” Traditionally, mobile lighting units are powered by diesel fuel generators that produce CO₂, NO_x (nitrogen oxides produced during combustion), and soot, putting them at odds with the environment. Sandia National Laboratories, with help from Boeing, the California Department of Transportation (Caltrans), and others, is leading an effort to develop commercially viable, environmentally friendly, fuel cell-powered mobile lighting systems.

Innovative Edge

Sandia is currently working on two separate lighting unit designs. The alpha unit was unveiled in October 2009 at the annual meeting of the American Association of State Highway and Transportation Officials (AASHTO). The alpha system consists of advanced power-saving Light Emitting Plasma™ technology (contributed by Luxim, Lumenworks, and Stray Light), two high-pressure hydrogen tanks (purchased by Sandia), a trailer with lighting mast (provided by Multiquip), and a fuel cell (provided and installed by Alteryg Systems). In addition to creating pollutants, conventional systems powered by diesel fuel generators are extremely noisy. Alteryg’s fuel cell systems, which run on pure hydrogen, are very quiet and produce zero emissions. Boeing funded Sandia to develop a beta design, which is more sophisticated and technically ambitious than its alpha predecessor. The beta unit uses metal hydride storage tanks, designed by Ovonic Hydrogen Systems, which allow the units to run around 60 hours longer

than the alpha design. Additionally, Sandians solved thermal management issues surrounding metal hydride storage. The low-pressure metal hydride design mitigates safety concerns about having high gas pressure on the unit.

Commercialization & Industry Impact

The end goal of the project is to make fuel cell technology readily available for commercial use, particularly in general construction and aviation maintenance applications. So far, the project has attracted the interest of the San Francisco International Airport, which would like to test the system for use in nighttime runway repair work. Caltrans also would like to deploy the unit in their road maintenance work in Sylmar, CA.



The alpha fuel cell light on display at the AASHTO show.

Sandia & CANBERRA *T-1A Fiber Optic Seal*

Background

If mechanical seals for safeguards containment are not checked regularly, the inspecting party may lose confidence in them. Seals are applied to monitored items to provide assurance that they are unchanged throughout the monitoring period. In a nonproliferation context, a higher level of assurance is required to ensure the applied seal is intact, implying that the item is intact. Sandia National Laboratories and its commercial partner CANBERRA are developing and commercializing smart seals that routinely “call home” to indicate their status and to report tampering.

Innovative Edge

The T-1A Optical Seal, developed at Sandia, is an active radio frequency (RF) based fiber optic device that is used for item monitoring, such as high value assets or special nuclear material in interim or long-term storage. The T-1A seal makes it difficult to remove material from containers without breaking the fiber optic loop seal. When the seal is broken, the T-1A transmits the event by RF to an associated monitoring system that collects the information for storage and review. These seals are intended for long-term use without maintenance—up to five years on one battery. The electronics are housed in a plastic case about the size of two decks of cards and can monitor a fiber optic loop up to 50 meters in length. The T-1A provides periodic state-of-health communications as well as immediate event notification. The device is also capable of message authentication and has active and passive tamper indicating features.

Commercialization & Industry Impact

The current T-1A product was brought to market by CANBERRA through the licensing of Sandia intellectual property. Subsequently, a CRADA was established between Sandia and CANBERRA to help streamline a commercial launch of the Secure Sensor Platform concept, which will produce the next version of the T-1A. The production of the T-1A units is a collaboration between CANBERRA, DOE’s Savannah River Site, and Sandia. CANBERRA commercialized the Sandia concept and brought it into production. Savannah River Site is a domestic customer for the T-1A seal.



Sandia optical seal in place on drums of radioactive materials.

Sandia & Compass Metals

Platinum Nanostructures for Enhanced Catalysis

Background

Renewable energy sources are critical to the nation's future, and hydrogen-powered fuel cells offer an attractive alternative to current technologies. However, fuel cell catalysts must become more durable, efficient, and inexpensive before they are practical and cost-effective. Most fuel cells use platinum or platinum alloys as catalysts, but the limited supply of platinum is a potential barrier to widespread fuel cell use.

Innovative Edge

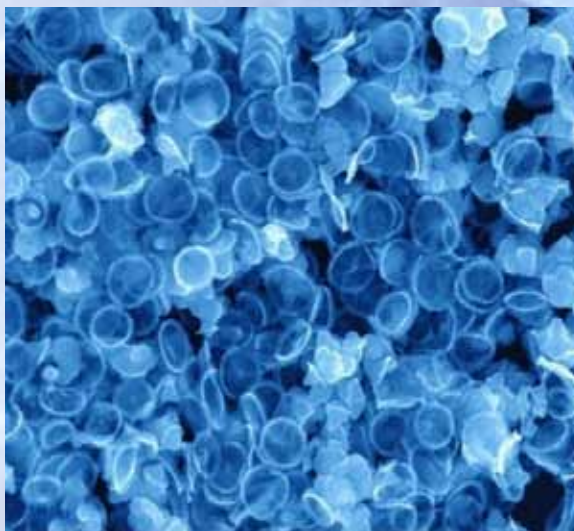
Sandia researchers have developed innovative methods of producing platinum catalysts that offer much greater control over the shape, size, porosity, composition, stability, and other functional properties of platinum nanostructures than those achieved by existing methods. Due to the high surface area and durability of the nanostructures, the process is expected to reduce platinum usage not only in fuel cells, but in other applications in the renewable energy sector as well.

Commercialization & Industry Impact

Sandia has licensed several patents to Compass Metals for the platinum catalysts. Under a multi-year cooperative research and development agreement, Sandia and Compass Metals are also collaborating to further improve the synthesis for platinum nanomaterials in large-scale preparations, as well as look into additional fields of use such as solar cells and organic field effect transistors. Compass Metals developed their first product called Platinum Nanocoral™ based on Sandia's patents and is exploring areas

of application beyond fuel cells. Compass is continuing to manufacture and provide one of the platinum nanomaterials (NanoCoral™) to fuel cell companies for evaluation. The group also won the 2009 Federal Laboratory Consortium Excellence in Technology Transfer Award.

FLC
FEDERAL LABORATORY CONSORTIUM



300-nm platinum nanodisks templated by surfactant bicellar disks.

Sandia & Cray, Inc. *Catamount N-Way Lightweight Kernel*



Background

Under an agreement with Cray, Inc., Sandia developed Catamount N-Way (Catamount) Lightweight Kernel technology. Additional technology development was made with the company Operating Systems Research through a sole source contract. The Catamount Lightweight Kernel leverages hardware capabilities of multicore processors to deliver significant improvements in data access performance for today's parallel computing applications. Catamount provides enhanced data access capabilities beyond other equivalent operating systems by employing a new technique that targets memory bandwidth, arguably the most important area of performance in scientific parallel computing. The Catamount Lightweight Kernel software is currently licensed to Cray, Inc.

Innovative Edge

Rather than explore costly and complex changes to software for scientific and engineering applications, Catamount attacks the problem of performance limitation at the operating system level. Using the existing features of a multicore processor to cut the memory bandwidth requirement of message-passing-based applications in half, Catamount provides new capabilities that significantly increase the raw performance of critical message-passing operations. These improvements greatly help to maintain the viability of existing parallel applications on quad-core processors and become increasingly more important on successive generations of multicore processors.

Linux, IBM's CNK, and Microsoft Windows are a few of Catamount's competitors, yet none of these operating systems natively provides the enhanced technology for shared data access for message-passing-based parallel applications that Catamount supplies. Catamount is capable of single-copy message passing, in-place collective operations, threaded collective operations, and support for one-sided operations. Additionally, Catamount preserves investment in existing applications. Catamount's competitors (Linux, IBM's CNK, and Windows) do not provide any of these capabilities.

Commercialization & Industry Impact

The multicore processor optimizations in Catamount have been implemented and demonstrated for one family of commodity multicore processors (X86-64), but a similar approach is viable on other multicore processors, such as the POWER processors from IBM and the SPARC processors from Sun Microsystems. The Catamount approach for optimizing intra-node data transfers would be straightforward to implement in other lightweight or embedded operating systems.

In May 2008, Catamount was deployed as the production compute node operating system on Sandia's Cray Red Storm computer. Currently, Catamount is licensed to Cray at a non-disclosed price. Additionally, Catamount won an R&D 100 Award in 2009.

Sandia & Critical Infrastructure Restoration

Building Restoration Operations Optimization Model (BROOM)

Background

The cost to shut down public facilities, plants, or businesses can be enormous. According to *Business Week*, the 23-day closure of Ronald Reagan National Airport in Washington, DC, after the 9/11 attacks were estimated at \$330 million per day to the airport and northern Virginia businesses and \$27 million to state and local tax revenues. To address this problem, Sandia National Laboratories developed BROOM: a software-based tool for managing the collection, visualization, and analysis of environmental sampling data. The BROOM system is the result of a six-year development effort funded by the Department of Homeland Security and included partnerships with San Francisco Bay area airports and Los Angeles International airports.

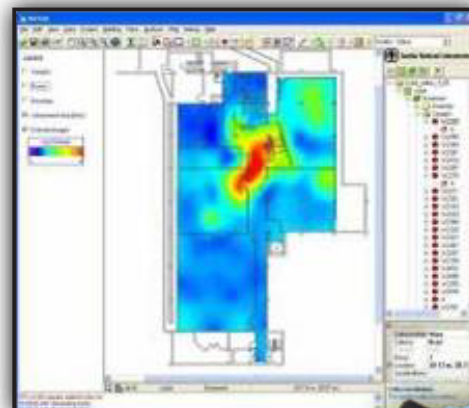
Innovative Edge

BROOM improves the efficiency of clean up operations, minimizes facility downtime, and provides a transparent basis for reopening the facility. The last factor is critical in gaining public and regulatory acceptance for declaring a facility to be “clean” and safe to reoccupy. Features provided by BROOM include integrated data collection and fast, efficient data management. BROOM has a unique patented feature for indoor positioning where GPS is denied. The visualization software easily provides the information needed to effectively and efficiently restore the facility to operation. It helps assess the contamination within a facility, plan operations to remediate that contamination, complete the clean up, and reopen.

Commercialization & Industry Impact

Applications and/or possible users for BROOM include environmental clean up (including Superfund sites), remediation operations, first responders, health agencies, airports, subways, government buildings, ports of entry, utilities, chemical plants, and many others. Sandia has a track record for developing commercially successful technology aimed at countering chemical and biological terror, including a decontamination formulation now licensed by MODEC, Inc. and EnviroFoam Technologies, Inc. BROOM was one of three technologies selected by the Department of Homeland Security for its Commercialization Pilot Program.

Sandia's BROOM tool can help restore facilities following release of biological warfare agents.



Sandia & Defense Technology Corporation of America *Diversionary Device*

Background

When U.S. military and law enforcement are dealing with potentially dangerous and deadly individuals, groups, and situations, every advantage they can utilize allows them to remain safer and more effective. Flash-bangs are diversionary devices that are non-lethal and are used to distract and disorient an adversary. These devices are important because they provide law enforcement and the military with an additional option in dealing with uncooperative or aggressive individuals and crowds. Until recently, the flash-bang had remained relatively the same since the original Mk 141 flash-bang was developed at Sandia National Laboratories. In 2008, Sandia licensed its safer fuel air diversionary device technology to Defense Technology Corporation of America to bring a new product to the market.

Innovative Edge

The new device better addresses more recent goals while also ensuring safety, effectiveness, and dependability. When activated, a cloud of aluminum powder is expelled by a gas generator, resulting in a disorienting explosion without any fragments. The device produces a very small scale dust explosion, which provides a bright flash of light and a loud sound report. The body of the device itself does not fragment or disintegrate, which makes it much safer and prevents accidental mishaps. Refillable units can be used for training to make it more economical. The new flash-bang resolves the hazards associated with flash-powder explosives and

potential mishaps associated with the old flash-bang devices.

Commercialization & Industry Impact

The new flash-bang technology is yet another step in creating state-of-the-art, non-lethal weapons now that address needs of the future. When a soldier or law enforcement officer can safely eliminate a threat with the help of a flash-bang, they can thank Sandia, Defense Technology Corporation of America, and its partners for aiding in their duty to protect and serve the American people.



Inventor Mark Grubelich with Lt. Chris Dallas and Tristan DeSantis of Sandia's Protective Force.

Sandia & EMCORE

Solar Photovoltaics, Fiber Optics, MODE, and Energy Efficiency



Background

MODE (MicroOptical Devices) was an Albuquerque-based start-up company founded by a group of Sandians who left Sandia under a special entrepreneurial program. MODE was purchased in 1997 by EMCORE, a New Jersey company that has worked with Sandia since the early 1990s. MODE technology was based on Sandia-licensed compound semiconductors used in manufacturing vertical cavity surface-emitting laser components. Upon acquiring MODE, EMCORE became the first company to build a facility in the Sandia Science & Technology Park (SS&TP) in 1998 for their Photovoltaics Division, which builds solar cells for the space industry. This division is built on technology also licensed from Sandia. Since 1998, EMCORE has grown to occupy over 172,000 sq. ft. of space with its two current divisions, EMCORE Fiber Optics and EMCORE Solar Photovoltaics. In October 2006, EMCORE moved its corporate headquarters to Albuquerque, NM. Sandia and EMCORE are currently working together through an ongoing private sector/national lab partnership on several new program opportunities. EMCORE works with Sandia's photovoltaic division on testing, design validation, and certification of concentrator photovoltaic components and modules.

Innovative Edge

EMCORE is a leading provider of compound semiconductor-based components for the fiber optics and solar power markets. In March 2009, EMCORE Fiber Optics introduced a tunable XFP product line that is capable of replacing fixed-wavelength dense wavelength division multiplexing XFPs as well as high-performance tunable 300-pin multi-source

agreed transponders. XFP refers to a form factor standard of 10 gigabit per second optical transceivers. The solar cell technology that EMCORE licensed from Sandia serves as the basis for their high-efficiency solar cells used in their concentrator photovoltaics (CPV) systems, which are used to generate solar power for terrestrial applications. In 2008, EMCORE was a recipient of an R&D 100 award for its world record Inverted Metamorphic (IMM) solar cell technology, which provides a platform for their next generation photovoltaic products. Solar cells built using the IMM technology have achieved record conversion efficiency of 33% used in space, and it is anticipated that the efficiency levels in the 42%-45% will be achieved when adapted for use in the terrestrial CPV systems.

Commercialization & Industry Impact

EMCORE's financial situation has improved substantially. The company is currently expanding business and hiring new employees. In June 2009, EMCORE signed an agreement with the Public Service Company of New Mexico (PNM) to become the first company to join PNM's Distributed Energy Solar Power Program. The 20-year agreement involves 114 kilowatts of solar power produced onsite at EMCORE's corporate headquarters in the SS&TP. The Sandia and EMCORE partnership has created hundreds of new, high paying jobs and has made an important contribution to the local technical community as well as the economy. Through technology transfer and commercialization, Sandia gained private sector funding for research, a stronger local research community, and products embodying Sandia technology, all of which support its national security mission.

Sandia & Fastrack Design

Xyce™



Background

Circuit simulation is the use of mathematical models to replicate the behavior of an actual electric circuit. It has been a major component of the electronics industry for over 30 years and is the foundation of the Electronic Design Automation (EDA) industry. EDA is a growing, billion dollar industry that comprises tools for designing and producing electronic systems, including printed circuit boards and integrated circuits. Previous generations of integrated circuits have been verified and tested using digital and/or hierarchical simulation techniques, but these are no longer adequate for modern feature sizes.

Innovative Edge

Sandia National Laboratories' Xyce™ 4.0.2 Parallel Electronic Simulator is the world's first massively parallel analog circuit simulator. Xyce™ is the only circuit simulation tool capable of simulating circuits in the 10 million device range. Xyce™ is able to accomplish this because of several unique features, including efficient distribution and load balance of a network problem in parallel and a truly parallel design based on message-passing implementation. It also accomplishes the effective use of preconditioned iterative solvers for circuits, which were previously thought to be impossible. Xyce™ 4.1 was released in 2008. It included additional SPICE MOSFET levels, a new suite of preprocessing commands, support for simulation of electromechanical and magnetically driven machines with an accelerated mass device and time-dependent mutual inductance, and other new features. Xyce™ has announced the release of the new Xyce™ 5.0. New features from the Xyce™ 5.0 include harmonic balance analysis,

new circuit-specific preconditioner, Trilinos 9.0 as the base solver library, cache memory-based performance improvements, updated radiation models, and new HSpice compatibility features.

Commercialization & Industry Impact

The Federal Laboratory Consortium recognized the Xyce™ 4.0.2 Parallel Electronic Simulator as a nominee for their commitment to technology transfer and support of the mission. Xyce™ also earned an R&D 100 Award. Fastrack Design, Inc., a small U.S. business located in California, has licensed the Xyce™ parallel electronic simulator technology from Sandia. Fastrack has created partnerships with many companies including leading semiconductor foundries. This transfer of the unique technologies within Xyce™ to the U.S. marketplace is anticipated to benefit the domestic economy and have a large positive impact on the EDA industry.



Sandia & General Motors

Biofuels, Hydrogen Storage System, and More

Background

For nearly two decades, Sandia National Laboratories and General Motors have collaborated on research and development projects related to transportation energy. Recent goals for this strategic alliance have focused on new reduced-carbon transportation energy systems to strengthen the American light vehicle industry. In coming years, Sandia and GM plan to extend their relationship beyond energy systems research into a variety of technology areas.

Innovative Edge

Two particularly successful ventures between Sandia and GM include a biofuels supply chain analysis and the development of hydrogen storage technology.

Biofuels: Sandia and GM researchers developed a tool known as the Biofuels Deployment Model to assess the feasibility, implications, limitations, and enablers of annually producing up to 90 billion gallons of ethanol—sufficient to replace more than 60 billion of the estimated 145 billion gallons of gasoline expected to be used annually in the U.S. by 2030. For one study, they determined that nationally 21 billion gallons of cellulosic ethanol could be produced per year by 2022 without displacing current food crops.

Hydrogen Storage: In 2003, Sandia and GM joined forces to develop solid-state hydrogen storage technology and tank design tools for light duty vehicle applications. With funding from GM, researchers at Sandia successfully designed and demonstrated key features of a hydrogen storage system that utilizes sodium alanate, a complex metal hydride. The system

stores 3 kilograms of hydrogen and is large enough to evaluate control strategies suitable for use in vehicle applications. The researchers identified attributes required of a future storage medium that would greatly contribute to success in mobile applications.

Commercialization & Industry Impact

Sandia and GM's biofuels deployment research created quite a stir, generating almost 100 inquiries including calls from congressional offices. The organizations plan to continue moving forward in the transportation energy arena and are exploring high-level strategies for advanced fuel development and deployment in Asia.



Sandia & Goodyear *Assurance® TripleTred™*



Background

Under a series of CRADAs, teams of scientists and engineers from Sandia National Laboratories and Goodyear have collaborated on technologies that complement the missions of both organizations for over sixteen years. By helping Goodyear computationally assess its innovative tire designs, Sandia researchers are improving their capabilities to provide solutions in support of Sandia's national security missions. The two organizations are currently collaborating on projects in areas including advanced mechanics tools, structural dynamics, and advanced materials. These are areas in which both organizations have inherent interest.

Innovative Edge

One of the most notable accomplishments of the partnership has been Goodyear's use of Sandia's computational mechanics tools to bring new, innovative products to market in record time. A radical new tread design featuring a three-part tread pattern optimized for driving in ice, rain, and dry conditions was the first product brought to market using Sandia's technology. Goodyear says the cycle time and performance goals achieved in the development of the Assurance® line of tires would not have been possible without the computational simulation tools developed with Sandia. Goodyear's new Fuel Max tires were recently developed using this technology.

Commercialization & Industry Impact

Goodyear cites its partnership with Sandia as critical to its business success and a cornerstone of its scientific foundation. The company says its work with Sandia multiplies the impact of its own technical capabilities by reducing new product development times, enabling better

products and manufacturing methods, increasing efficiency, and significantly improving R&D effectiveness. These are critical technological advantages in the fiercely competitive and complex tire industry. The Assurance® line, featuring TripleTred™ technology, earned a number one rating from the top U.S. consumer magazine. In 2005, Goodyear and Sandia shared a prestigious R&D 100 Award for the development of the TripleTred™ tire.



Hal Morgan, manager of Sandia's CRADA with Goodyear, looks at the tread of a Goodyear tire.



Sandia & Honeywell, MIT, and Polychromix *Lunar Mission Near-Infrared Spectrometer*

Background

In October 2009, a NASA spacecraft crashed into the moon, kicking up debris containing 25 gallons of water. Key to verifying the presence of water in such a significant amount were two near-infrared spectrometers that NASA had obtained from Polychromix, Inc. of Wilmington, MA. Simply put, the spectrometers looked at reflected sunlight from the lunar debris for features characteristic of water—and found them. A number of current and former Sandia scientists had been paying particular attention to this NASA operation because the space-traveling Polychromix spectrometers are direct descendants of a device they had developed and patented several years earlier—a MEMS-based diffractive optical component.

Innovative Edge

Michael Butler, one of the Sandia inventors, had left Sandia in 2001 to become a founding vice president at Polychromix, joining Professor Stephen Senturia of MIT, a former Sandia consultant and co-inventor of the technology. Butler recalls the original work on their MEMS-based diffractive optical component involved teaming with MIT and Honeywell and was supported to the tune of \$8-million by the

Defense Advanced Research Projects Agency (DARPA). DARPA was interested in the component for possible use in remote sensing.

Although the application which interested DARPA has never been commercialized, Polychromix saw value in the Sandia device, which by that time had been christened the Polychromator. Polychromix obtained an exclusive license and adapted the Sandia device and technology initially to optical telecommunications needs, but has further improved and modified it for use in the company's evolving focus areas.

Commercialization & Industry Impact

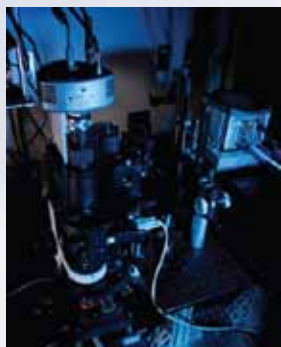
MEMS (micro-electromechanical systems) involve using semiconductor silicon fabrication technology to build devices that perform myriad mechanical or optical-mechanical functions. MEMS enable construction of inexpensive, rugged, high-precisions, low-power miniaturized devices that over the years have found their way into consumer goods—vehicle airbags and suspensions, mountain-bike altimeters, cell phones, and video games—along with NASA spacecraft.

Sandia & Monsanto *Hyperspectral Confocal Fluorescence Microscope System*



Background

A CRADA between Sandia National Laboratories and Monsanto Corporation has resulted in the construction of a copy of Sandia's prototype hyperspectral confocal fluorescence microscope customized for Monsanto's plant



cell research interests. Monsanto has been using this microscope for the past three years to obtain insightful information into their plant research. This patent-pending technology has been combined with Sandia's proprietary Multivariate Curve

Resolution (MCR) algorithms which extract qualitative and quantitative information obtained from the hyperspectral imaging microscope. This system is a powerful analysis tool for hyperspectral images, capable of rapidly discovering all emitting fluorescence species in an image and determining their relative concentrations without any a priori information.

Innovative Edge

With this new microscope system, large numbers of fluorophores can be monitored simultaneously without cross talk to achieve higher throughput, greater quantitative accuracy, and increased reliability. The hyperspectral microscope has been especially useful for multiplexed 3D imaging of living cells at diffraction-limited spatial resolutions in a large variety of biological applications. This microscope system is able to collect hyperspectral images of 512 wavelengths at unprecedented acquisition speeds of 8300

spectra/second. The associated MCR software uses new algorithmic approaches to perform rigorous constrained alternating least squares analyses at computational speeds and robustness that far outperform externally available software. In combination, the microscope and software provide a unique system that allows the user to discover and quantify fluorescence species that other microscopes are not able to distinguish or quantify.

Commercialization & Industry Impact

Although other researchers have recently developed hyperspectral confocal fluorescence microscopes, none have the speed with which the information is acquired and the multivariate image analysis capabilities that make the Sandia system unique. In fact, Sandia was awarded a 2009 R&D 100 Award for this innovative technology. As of yet, no commercial units have been produced. Initial commercial units are estimated to cost between \$300,000 and \$500,000.

“*This product enabled us to visualize cellular structures and components not detected by commercially available confocal microscopes, and it enabled the development of new approaches and protocols impossible to carry out successfully due to technical limitations of traditional confocal microscopes.*”

Maria Cristina Ubach
Ph.D., Monsanto Company

Sandia & the Nanoparticle Flow Consortium

Modeling & Simulation

Background

At the scale of nanoparticles, attractions and repulsions among atoms and molecules often overwhelm the forces that dominate in the larger-scale world. Such nanoscale forces become a problem when the goal is to keep particles evenly dispersed in liquid—a challenge for manufacturers who want to make products featuring nanoparticle-enhanced films or coatings. Nanoparticles suspended in solvents at high densities tend to clump while the coating is drying, negating the benefits of their nanosized ingredients. Improving the processing and manufacturability of such coatings and thin films is the primary goal of a research collaboration among Sandia and five major companies. The Nanoparticle Flow Consortium includes 3M, BASF, and Corning, among others. Sandia serves as the hub for the three-year, \$2 million CRADA.

Innovative Edge

The consortium's work addresses two main technical challenges: (1) stable dispersal of nanoparticles in solution during processing and (2) improved understanding of particles dispersed in materials under stress or flow and how these states are affected by nanoscale forces. Both challenges were viewed by participants as limiting factors in bulk manufacturing of nanomaterials and thin films.

Sandia is developing the modeling and simulation tools needed to understand liquid flow chemistry, nanoparticle dispersal stability, and particle control. Together with Sandia's high-performance computers, the tools developed constitute a predictive stimulation capability for nanoparticle processing—meaning materials and

techniques with the highest chances of success can be designed on computers before they are ever tried in a laboratory. The modeling tools will be available to all consortium partners.

Commercialization & Industry Impact

The National Science Foundation estimates that by 2015, the worldwide nanotechnology market could reach a trillion dollars annually. Today's flat-screen televisions already incorporate nanofilms in their display screens. On the horizon are stronger and more transparent glues, lightweight composites, sealants for microelectronics devices, and new materials for sensing and medical devices. Possible future products include coatings that react to the environment, paint or glass that color-shifts like a chameleon, self-lubricating or self-healing surfaces, and antimicrobial coatings for hospital ventilation systems.



Nanoparticle-enhanced coatings are critical both to solid state lighting and high-resolution consumer flat panel displays.

Sandia & New Mexico Biotech *ElectroNeedle™ Biomedical Sensor Array*



Background

The Sandia-developed ElectroNeedle™ Biomedical Sensor Array is a device that, when pressed against the skin, provides rapid, on-demand, multiplexed, point-of-care biomedical assays for medical diagnosis.

Innovative Edge

The ElectroNeedle™ Biomedical Sensor Array's ability to provide rapid, on-demand diagnostics is especially critical in emergency, battlefield, and remote settings where time constraints or distance make it impractical to send the patient's samples to a conventional laboratory for analysis. It also eliminates the delay experienced by many patients and physicians in waiting for diagnostic test results. Finally, it enables a new dimension in home healthcare, where patients can be routinely monitored and the results transmitted to a physician. Although human healthcare is the principal application for this technology, the ElectroNeedle™ Biomedical Sensor Array also has equivalent veterinary applications. Rapid and low-cost disease detection in agricultural livestock will produce an enormous economic impact worldwide.

Commercialization & Industry Impact

The significance of the ElectroNeedle™ technology has been recognized by both the commercial sector and by the medical community. A new biotechnology company—New Mexico Biotech, Inc.—has been formed in Albuquerque explicitly for ElectroNeedle™ commercialization. New Mexico Biotech has licensed the technology from Sandia and plans to develop the commercial product, to pursue FDA

approval for the product, and to provide funding to Sandia for continued R&D. Additionally, the ElectroNeedle™ Biomedical Sensor Array was awarded an R&D 100 Award in 2007.



When pressed against a patient's skin, an ElectroNeedle™ patch can detect and identify biological markers just beneath the skin's surface.

Sandia & Novint

Novint Falcon

Background

Tom Anderson pioneered the development of some of the world's first 3D touch applications at Sandia National Laboratories. On a leave of absence through Sandia's entrepreneurial separation program, Anderson started a successful 3D touch computing business, Novint. Novint's software technology is based on technology originally developed at Sandia, which was licensed to Novint for commercialization. Novint partnered with Lunar Design, an award-winning industrial design firm, and Force Dimension, a leading Swiss developer of high-end haptic devices, in the development of the Falcon.

Innovative Edge

The award-winning Novint Falcon is the first controller that makes high-fidelity, interactive, three-dimensional touch possible and practical for consumer computing applications. Novint Falcon is, essentially, a small robot, yet its industrial design is something that consumers can utilize on their desktop. With the Falcon, users have the ability to feel weight, shape, texture, dimension, dynamics, and force when playing enabled games, creating realistic touch sensations that allow users to control a game naturally and intuitively. Users can actually feel the weight of a basketball as they shoot it toward a hoop, the momentum and impact as they swing a virtual golf club and strike a ball, the recoil of a weapon, the characteristics of virtual objects, and much more. Novint Falcon is also the only consumer game controller that provides players with both 3D input and high-fidelity force feedback. Additionally, Novint recently released

the Pistol Grip which creates an immersive FPS gaming experience.

Commercialization & Industry Impact

In 2007, the Novint Falcon won an R&D 100 Award. The partnership also earned a Federal Laboratory Consortium Award for Excellence in Technology Transfer. Novint has recently announced agreements with several of the industry's leading entertainment software companies, including EA, Valve software, and a multitude of AAA titles to the Falcon lineup. Currently, the Novint Falcon is available both in the U.S. and internationally.



Novint's Falcon Controller is the first consumer 3D touch controller that gives a user a very precise sense of touch on a computer.

Chuck Andraka in front of the Stirling array
at Sandia National Laboratories.

Sandia & the Soldering Industry

Lead-Free Solder

Background

Solder holds electronic components together and bonds other connections. Solder alloys containing lead have traditionally been used for many years and work great. The problem is that lead is toxic and needs to be replaced. The world is increasingly sensitive to the environmental impact in the manufacturing, use, and disposal of electronics. According to the United Nations, up to 50 million tons of electronic waste is generated annually. About 70% of that waste ends up in China, which generates an enormous threat to the environment through air pollution and run-off into groundwater.

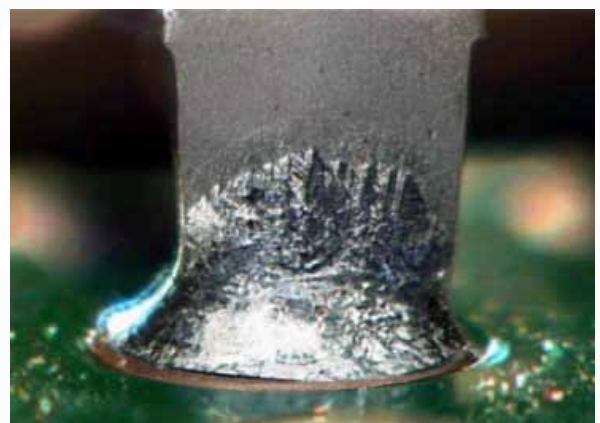
Innovative Edge

Sandia National Laboratories has been at the forefront of lead-free soldering technology for more than twenty years. It started with lead-free alloys that allowed the plumbing industry to meet the Clean Water Act requirements that prohibited lead-bearing solders from potable water systems. In collaboration with Ames Laboratory and Iowa State University, tin-silver-copper solders were developed for consumer and military applications and have been licensed for many commercial applications by Iowa State University. Sandia researchers are involved

in lead-free solders for electronics, working with Lockheed Martin, Honeywell, and other corporations. New alloys being developed at Sandia include several novel compositions for hybrid microcircuit and elevated temperature applications.

Commercialization & Industry Impact

Sandia has shared its lead-free solder expertise with corporations such as Indium Corporation, Johnson Manufacturing, and others who are helping reduce the millions of tons of electronic waste. Lead-free solder is still a key source of royalty income at Sandia.





Sandia & Stirling Energy Systems *Solar Dish Collectors*

Background

One source of alternative energy is the use of solar dish collectors. A partnership between Sandia and Stirling Energy Systems (SES) produced a new record for the efficiency of new solar-to-grid system conversion. On January 31, 2008 the net efficiency was 31.25%, which eclipsed the previous record of 29.4% from 1984.

Commercialization & Industry Impact

The CRADA between SES and Sandia has played a large role in making solar power more attractive in the eyes of potential utility customers. SES is now establishing new partnerships with manufacturing and industrial organizations to employ cost-effective, high volume manufacturing processes, thereby developing a supply chain with a higher probability of success. Sandia and SES received the *Popular Mechanics* Breakthrough Innovator Award which celebrates the top ten innovations poised to change the world. SES and Tessera Solar (the commercial development portion of SES) recently unveiled four newly designed solar



power collection dishes at Sandia's National Solar Thermal Test Facility. SES has signed power purchase agreements with Southern California Edison, San Diego Gas & Electric, and CPS Energy in west Texas. The projects are expected to produce 1,000 MW by the end of 2012.

Innovative Edge

The modular CSP SunCatcher uses precision mirrors attached to a parabolic dish to focus the sun's rays onto a receiver, which transmits the heat to a Stirling engine. The engine is a sealed system filled with hydrogen. As the gas heats and cools, its pressure rises and falls. The change in pressure drives the piston inside the engine, producing mechanical power, which in turn drives a generator and makes electricity. The new SunCatcher is about 5,000 pounds lighter than the original, is round instead of rectangular to allow for more efficient use of steel, has improved optics, fewer mirrors, and consists of 60 percent fewer engine parts. The improvements will result in high-volume production, cost reductions, and easier maintenance.



Sandia & Thermo Fisher Scientific *ARIS.net*



Background

The entry of fissile material in the form of a dirty bomb or nuclear weapon through America's ports continues to be a major threat to the nation. Sandia recently concluded a CRADA with Thermo Fisher Scientific (formerly Thermo Electron Corporation) that licensed the Sandia-developed FitToDB algorithm for commercial use in a spectroscopic portal to identify concealed nuclear devices. Thermo Fisher Scientific has developed ARIS.net, a state-of-the-art advanced radiological identification/detection system using Sandia's scanning algorithms that enhance the probability of threat detection.

Innovative Edge

ARIS.net is designed to interdict radioactive materials at border crossings, control points, sea containers, and pedestrian portals. ARIS.net offers high-sensitivity and unparalleled radiological detection capability for identifying isotopes under the most difficult and stringent real-world environments. These algorithms extract vital isotopic signatures from smeared spectral data caused by distance, varying geometries, shielding and movement of the monitored objects or persons. Highly sensitive detectors, time tested algorithms, state-of-the-

art electronics, optimized real-time operating system and open architecture all combine to rapidly deliver a dependable and long-term solution to guard against the ever clear and present dangers facing us all.

Commercialization & Industry Impact

Sandia's efforts earned them the Federal Laboratory Consortium Excellence in Technology Transfer Award. Thermo Fisher has used the FitToDB algorithm and sensor design principles imparted during the technology transfer process to construct several sensors that have been delivered to various sponsors. Sensors that will be used for domestic applications include several ARIS portals that were delivered to the Defense Threat Reduction Agency and two Advanced Spectroscopic Portals delivered to the Domestic Nuclear Detection Office. Thermo Fisher also developed portals for use under the Megaports program. These sensors (ARIS-2) include a stationary installation and a mobile system.

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innovation
through partnerships



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