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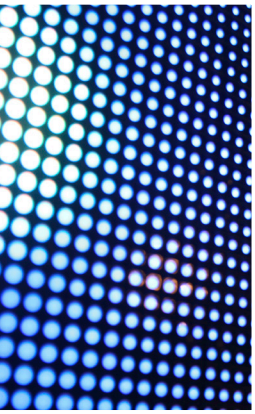
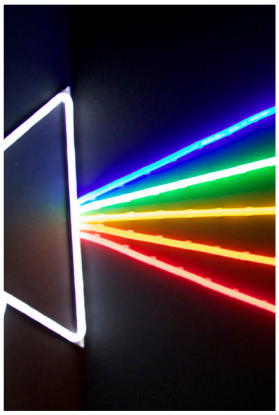
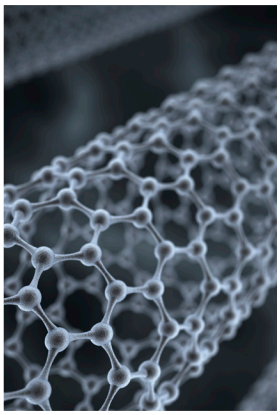

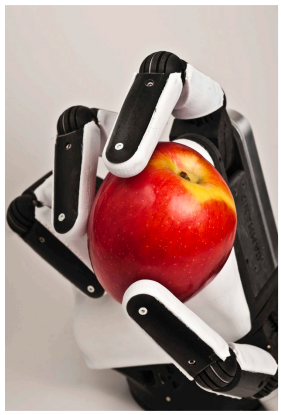
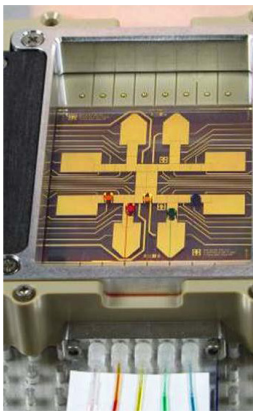

Sandia's INNOVATION MARKETPLACE

A QUARTERLY UPDATE OF AVAILABLE TECHNOLOGIES FOR INDUSTRY

July 2015 • Vol 2, Issue 2

Welcome to Sandia National Laboratories' Intellectual Property Magazine

Sandia's Innovation Marketplace is a quarterly e-magazine published by Sandia National Laboratories. This publication highlights exceptional opportunities for licensing Sandia's intellectual property, including patents, copyrights (generally software), trademarks, and mask works. Listings within should not be construed as an offer to license technology. All licenses are subject to negotiation and availability of the intellectual property for licensing. This publication is intended for indications of interest only.

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The Best and Brightest

In keeping with our vision to be the nation's premier science and engineering laboratory for national security and technology innovation, we recruit the best and the brightest, equip them with world-class research tools and facilities, and provide opportunities to collaborate with technical experts from many different scientific disciplines. The excitement and importance of our work, an exemplary work environment, partnerships with academia, industry, and government, and our record of historic contributions help us attract exceptional staff. Our employees are recognized by their professional peers for their outstanding contributions.

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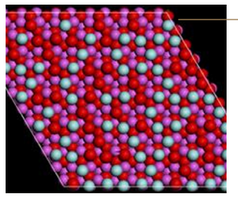
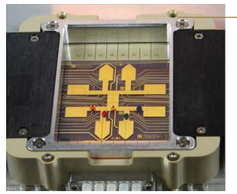
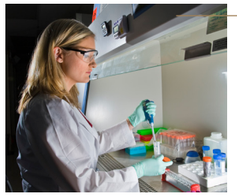
Technology Categories







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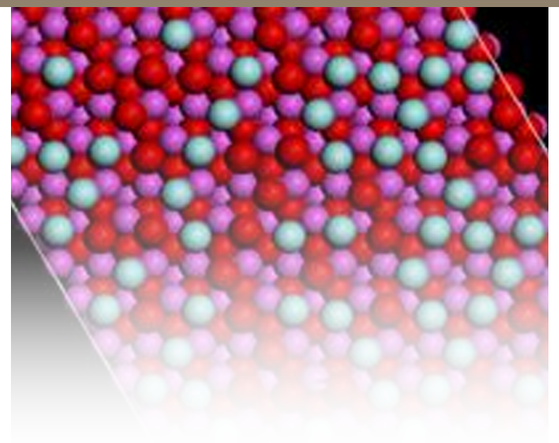


Metal Fluorite-Based Inorganic Material is capable of capturing and immobilizing radioactive nuclei

US Patent # 9,000,250

Nuclear power represents an infinite source of power generation but possesses multiple complications— one of the most significant concerns is the safe disposal and isolation of nuclear waste. Trapping and immobilizing radionuclides, such as iodine and technetium, represents a great technical challenge due to their high mobilities. In addition, these radionuclides exhibit long half-lives that are highly soluble and poorly absorbed by natural materials.

To address this growing problem, scientists at Sandia have developed a method to capture and immobilize radioactive nuclei using metal fluorite-based inorganic materials. The process involves flowing a gas stream of radioactive species through an exhaust apparatus that contains the fluorite-based material. Fluorite-based materials perform better than current oxide-based materials, with their sorption affinity for gaseous iodine around two to three orders of magnitude stronger. Sandia's material is highly effective, capable of trapping higher amounts of radioactive material than its conventional counterparts.

Applications and Industries

- Nuclear energy & security
- Medical devices
- Chemical separation
- Environmental cleanup

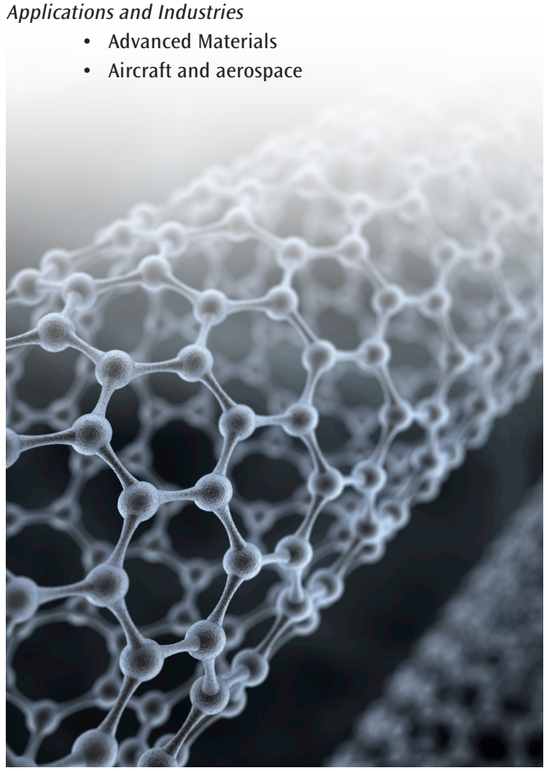
Carbon Nanotube Composite Materials improve nanotube dispersion and electrical conductivity

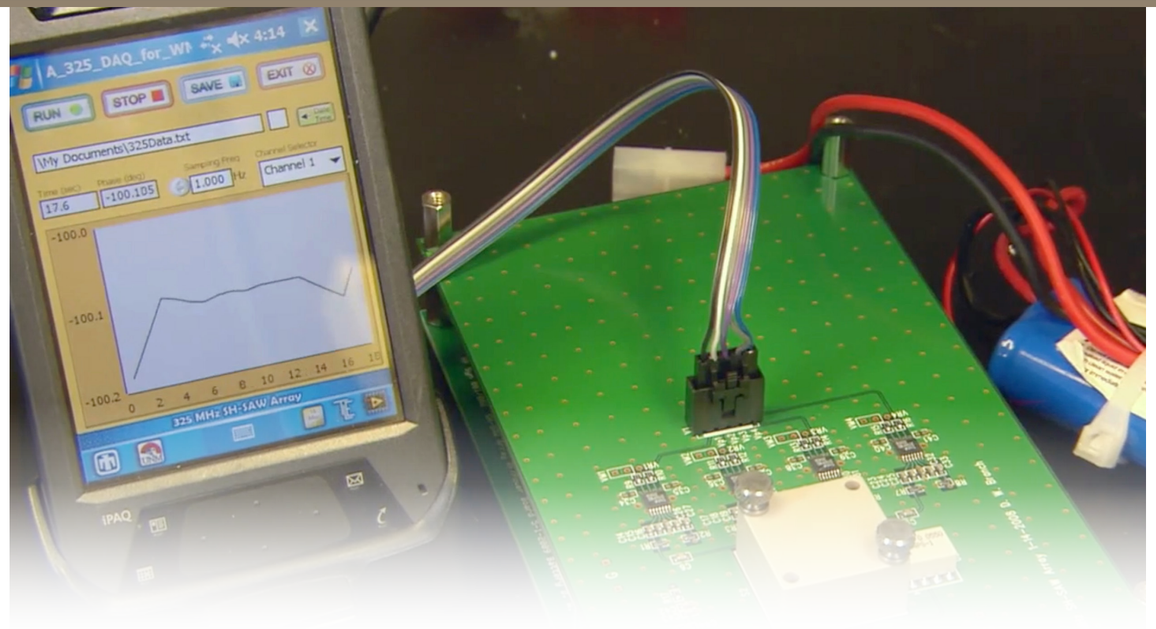
US Patent # 8,986,576
US Patent # 8,728,566

When mixed into a polymer matrix, carbon nanotube-filled polymer nanocomposites impart enhanced mechanical, thermal and electrical properties. Carbon-based fillers can exhibit high conductivity, low weight and ease of processing. Sandia's method utilizes a composite material that consists of a vinyl thermoplastic polymer, un-functionalized carbon nanotubes and hydroxylated carbon nanotubes dissolved in a solvent. Either single wall or multi-wall carbon nanotubes can be used. Sandia's carbon nanotubes can be blended with a variety of matrix materials, resulting in a polymer mixture with improved nanotube dispersion at lower fill percentages and enhanced electrical properties. As a result, Sandia's carbon nanotubes can be utilized on a smaller scale, reducing the overall cost.

Applications and Industries

- Advanced Materials
- Aircraft and aerospace





Acoustic Wave Biosensor is a portable and convenient tool that can accurately measure and analyze a variety of biological pathogens

US Patent # 8,436,509

Sandia's shear horizontal surface Acoustic Wave Biosensor is a handheld, battery-powered, portable detection system that identifies a wide range of medically relevant pathogens based on their biomolecular signature. Complex, real-world environmental samples including air, water, food, and soil are easily analyzed by the system. Pathogens detected include viruses, proteins, bacteria, and DNA. Detection occurs within minutes at the point-of-care. System control, data analysis, and reporting of the relevant information are all performed by a simple personal digital assistant.

Sandia's biosensor uses a surface acoustic wave microsensor, making it highly sensitive to changes in mass or viscosity at the sensor surface. The device also includes an array, which is functionalized with select ligands – antibodies, peptides, or single-strand DNA, depending on the application. This sensor acts as a miniature analytical balance by weighing the amount of pathogen that binds to its surface. The sensor behaves similar to a spring: as more pathogen binds, the bouncing of the spring decreases. By analyzing the speed of the bouncing, the amount of pathogen present can be accurately determined. These sensors have the potential to significantly impact the area of medical diagnostics due to their small size, sensitvity and selectivity.

Applications and Industries

- Healthcare
- Medical devices
- Pharmaceutical
- Agriculture

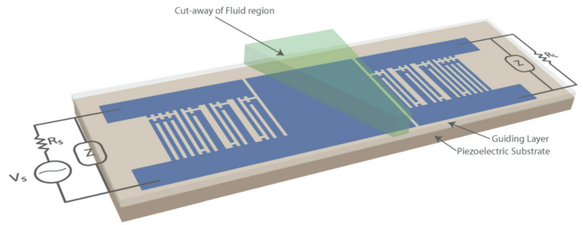


Figure 1: Schematic diagram of SAW sensor for detection of biological pathogens in fluids

Time Encoded Radiation Imaging *detects the presence of gamma-rays and neutrons in special nuclear materials*

US Patent # 8,866,100

Time encoded imaging (TEI) is a new approach for standoff detection of special nuclear materials. The invention relies on encoding directional information in the time dependent modulation of fast neutron detection rates. Other imaging methods require either multiple interactions (e.g. neutron scatter camera or Compton imagers), which lead to intrinsically low efficiencies, or spatial modulation of the signal— with the latter requiring complicated, high channel count, and expensive position sensitive detectors.

Sandia's rotational self-modulation design concept for time-encoding the direction information relies on simple compact construction with large detection volumes that minimizes complexity and simplifies calibration but maintains high efficiency. Utilization of directional information enables on-the-fly background estimation which enhances sensitivity while eliminating the need for a separate reference background measurement. The scalability of Sandia's TEI systems makes them a very promising detector class for weak source and large standoff distance detection.

Applications and Industries

- Nuclear security & non-proliferation
- Medical imaging
- Homeland security
- Treaty verification

All Fiber Passively Q-Switched Laser *creates short and energetic laser pulses without sacrificing quality*

US Patent # 9,031,098

Q-switching is a technique that allows users to generate short, energetic pulses from a laser. Changing the strength of cavity (Q) from high to low, accumulates energy during the strong cavity phase which dissipates at once, resulting in a giant laser pulse. Typical Q-switched laser pulses achieve milli-joule energy within a several nanosecond pulse duration, suitable for industrial laser marking and metal processing.

Conventional Q-switched lasers are based on free-space bulk saturable absorber crystals, which make the lasers intrinsically vulnerable to long-term and short-term mechanical instabilities. Sandia's Q-switched laser is an all-fiber structure based on a doped-fiber saturable absorber. A large core doped fiber acts as a gain medium whereas a small core doped fiber acts as a saturable absorber. When fused together, an all-fiber passively Q-switched fiber laser is created. A careful parameter adjustment, which Sandia developed through its home-built sophisticated fiber laser simulator, is the key for higher energy and shorter pulse duration.

Applications and Industries

- Advanced manufacturing
- Aircraft and aerospace
- Electronics
- Medical devices
- Semiconductor manufacturing

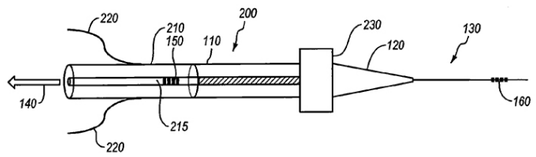
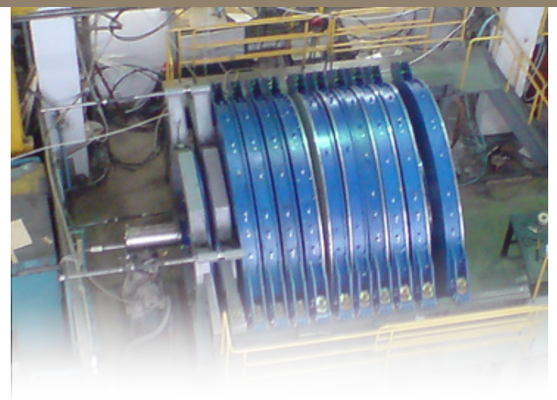


Figure: Illustration of fiber passively Q-switched laser



Linear Transformer Driver *generates high current, high voltage power pulses for Z-pinch applications*

US Patent # 9,000,625

Linear transformer drivers (LTD) represent a class of accelerators that possess the ability to achieve rapid, high current and voltage power pulses. LTDs create high power pulses by switching through various power delivery modules, while simultaneously incorporating pulses at low voltage through low inductance transfer and soft iron or other ferromagnetic material core isolation. Conventional LTDs produce sine-shaped pulses that may not be well suited for applications such as z-pinch drivers, flash radiography, high-power microwaves, etc. To address this limitation, Sandia developed an LTD capable of producing flat- or trapezoidal-shaped pulses. Sandia's driver contains at least one ferrite ring and incorporates multiple levels of power delivery modules in order to generate a high voltage pulse needed for Z-pinch applications.

Applications and Industries

- High current Z-pinch inertial confinement fusion
- Z-pinch inertial fusion energy drivers
- Flash radiography

Laterally Injected Light-Emitting Diode *emits brighter light and is more efficient than the conventional LED*

US Patent # 9,059,356

Achieving p-type conductivity is a major challenge that limits the performance of many ultraviolet (UV) optoelectronic devices. Sandia has created a light-emitting diode and subsequent laser diode designs that employ p-type AlGaN-AlN superlattices with 1 nanometer thick layers to achieve high lateral p-type conductivity and high transparency in the UV region. Combined with an etch process for ultra-smooth facets, these superlattice structures enable several distinct laterally-injected device designs with numerous advantages over standard vertically-injected structures. These advantages include: 1) increased hole injection and carrier concentration; 2) avoidance of absorption loss from lower bandgap p-type capping layers; 3) the ability to grow upon semipolar planes, lessening internal polarization fields in quantum well active layers and increasing radiative efficiency and; 4) design flexibility for simultaneous hole injection and low-loss mode confinement in deep-UV laser diodes.

Applications and Industries

- Fluorescence-based biological/chemical sensing
- Epoxy curing
- Water purification

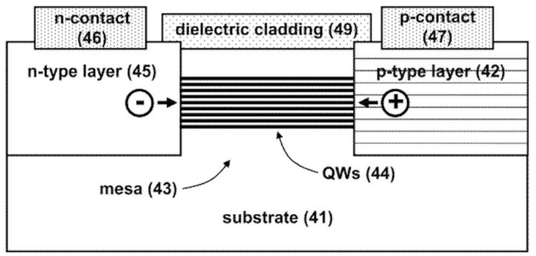
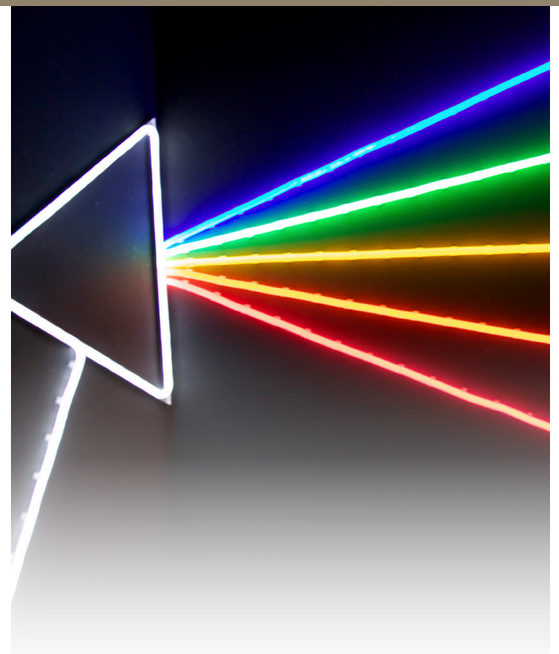


Figure: Laser diode design enabled by p-type superlattices



Sandia's **Photon Detector** *is configured to employ the Gunn Effect, enabling greater efficiency*

US Patent # 8,981,312

Conventional photon detectors utilize materials such as gallium arsenide, which is acceptable but hinders the number of residual donors of acceptors, thereby limiting carrier concentration. Sandia created a photon detector that employs the Gunn Effect to detect high energy photons such as those displayed by x-rays and gamma rays. Few materials exhibit the Gunn Effect, which grant electrons greater ease of movement while generating a high-frequency alternating current. Sandia's photon detector includes a p-i-n semiconductor diode that contains a p- and n-type semiconductor region with the i-region lying in between. The photon detector also eliminates the low efficiency rates demonstrated by conventional gallium arsenide gamma detectors.

Applications and Industries

- Photodetectors
- Spectroscopy

Multicolor Photonic Crystal Laser Array *provides users with ease of light customization*

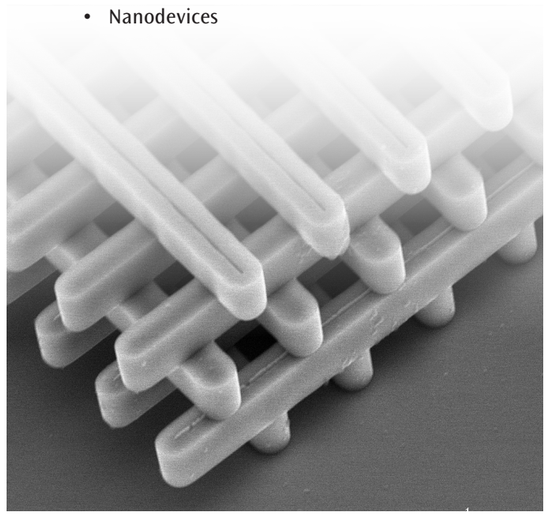
US Patent # 9,020,005

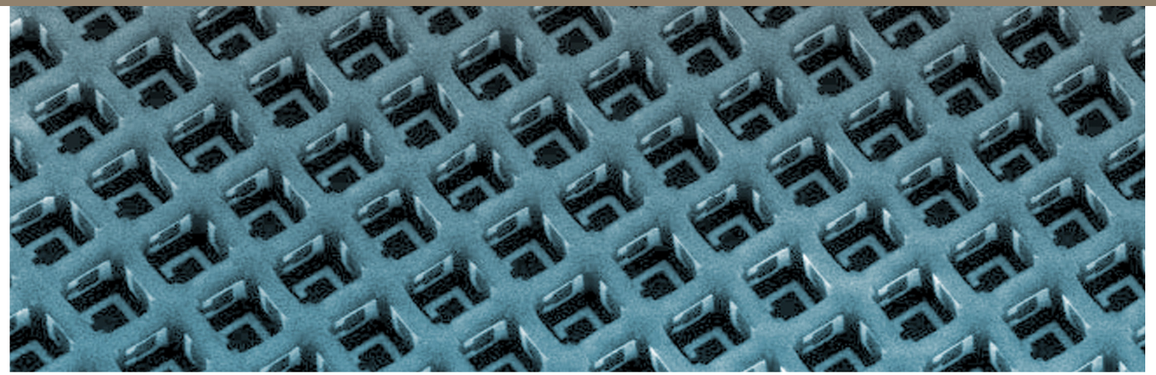
Surface-emitting photonic crystal lasers represent a potential source of light for future generations, but are currently limited by the number of accessible wavelengths on a single device. Direct emission displays require high brightness emitters that span the entire visible spectrum. Other emerging applications such as solid-state lighting require micro-scale parts with controllable lasing wavelengths.

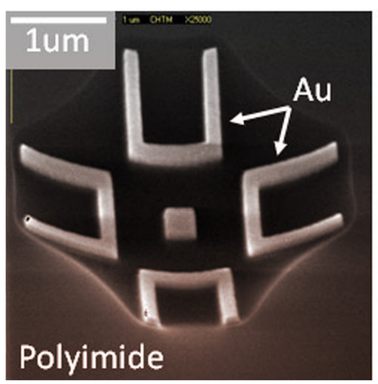
To address this problem, Sandia developed a multicolor photonic crystal laser array. The invention is comprised of an array of 2D vertically-emitting photonic crystal nanowire lasers designed to emit at a distinct lasing wavelength between 350 and 650 nanometers. The advantage of this technique is that users are able to incorporate multiple lattice periods to create laser pixels of various wavelengths. In turn, creating an array of photonic crystal laser pixels that provides users with the customization to emit light of widely varying colors from a single device.

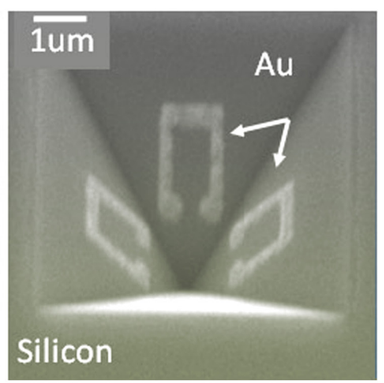
Applications and Industries

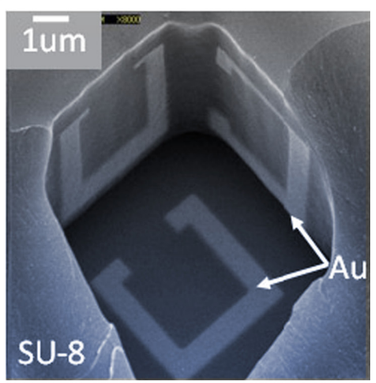
- Solid-state lighting
- Display lighting
- Direct emission displays
- Computing
- Microelectronics
- Nanodevices











Membrane Projection Lithography *is a novel technique that allows users to create multiple 3D structures at the micron level*

US Patent # 8,981,337

Membrane projection lithography (MPL) is a novel microfabrication technique used to create three dimensional micron-scale integrated circuits. The process begins by forming a micro-cavity structure of matrix material that can take a curved, cylindrical, spherical, ellipsoidal, cubic, prismatic, or conic shape. The cavity is then filled with backfill material and a membrane is formed over the cavity. An opening is produced in the membrane which acts as a mask over the structure and controls the area of the cavity that is subjected to the fabrication operation. Next, the backfill material is removed and structures are produced within the cavity by a deposition, implantation, or etching operation through the suspended, patterned membrane. By changing the direction of the operational beam in relation to the membrane opening, the various surfaces of the cavity can be utilized to form a plurality of structures. If additional structures are required, the original membrane can be removed, a new membrane formed, and further implantation, etching, or deposition operations can be executed.

Sandia's MPL process can be utilized to produce semiconductor components that do not run parallel to a wafer surface, allowing for a higher complexity of integrated circuits at the micro level. It is also capable of creating structured electromagnetic materials. While current sub-micron 3D fabrication techniques are complicated processes that require non-standard equipment and lack high-volume scalability, MPL is an efficient technique that can be performed in any standard semiconductor processing fabrication facility. MPL produces results that exhibit uniformity, repeatability, and high yield.

Applications and Industries

- Semiconductor manufacturing
- 3D integrated circuits
- Structured electromagnetic materials
- Thermal antennas
- Biological research

Automated Molecular Biology Platform represents a fast and inexpensive integrated power source for MEMS technology

US Patent # 8,940,147

The advent of next generation DNA sequencing (NGS) technology represents a quantum leap in the field of genetic analysis: what once required a decade-long, multibillion dollar Human Genome Project can now be reproduced in 1-2 weeks time for less than $5,000. Despite advances in sequencing technology, upstream library sample preparation protocols, which require numerous sample processing steps and hours of hands-on laboratory time, have not benefitted from comparable increases in speed or efficiency. While automation of the library preparation process can help overcome this widely recognized bottleneck, current approaches rely on large and expensive pipetting robots designed for use in dedicated high-throughput sequencing facilities. Technologies automating NGS sample preparation must also become more affordable to fully realize the potential of next generation sequencing for more ubiquitous, individualized, decentralized applications such as personalized genomic medicine, point-of-care diagnostics, public health screening, and DNA forensics. To address this need, Sandia developed an Automated Molecular Biology (AMB) system enabling the cost-effective automation of complex protocols like NGS library preparation and other labor-intensive bioanalytical procedures and processes.

The heart of the AMB system is a unique droplet-based digital microfluidic (DMF) platform which functions as a central hub for the distribution and routing of samples and reagents. DMF technology uses electrostatic and electrowetting forces to manipulate microliter-scale droplets sandwiched between closely spaced, hydrophobically coated substrates patterned with individually addressable electrodes. These devices enable discrete droplet movement and droplet operations such as merging, splitting, mixing, and aliquotting to be performed at scales much smaller than what can be conventionally achieved. Accordingly, Sandia's DMF platform functions instead as a sample distribution and reagent interface hub and is equivalent to that of a pipetting robot in a high-throughput laboratory automation workflow, but at a fraction of the size, cost, and complexity. The estimated price of a full AMB platform including all supporting hardware and software will cost less than $3,000 per unit.

Applications and Industries

- Public health
- Forensics
- Bio-surveillance
- Medical devices

Advanced Forms of Activated Carbon provides users with a novel way to test conventional integrated circuits

US Patent # 8,945,277

Sandia has developed an economical and efficient activated carbon adsorbent that is fire-resistant with spontaneous ignition temperatures of up to 860°C and favorable sorption capacity. Sandia's activated carbon possesses high gas adsorption capacities and rapid adsorption kinetics comparable to commercially-available alternatives, while also demonstrating superior performance in comparison to the use of conventional zeolite materials such as mordenites. The adsorbent can be used to trap noble gases including Argon, Krypton, Xenon and radioactive ^{85}Kr.

This technology is well suited for a variety of applications including the chemical and petrochemical industries, where such materials are used to control emissions of solvents and other volatile organic compounds from process streams, off-gases and tank venting. Similar applications exist in the environmental engineering, nuclear, military and extracting arenas.

Applications and Industries

- Gas capture and storage
- Mining
- Waste management
- Water purification
- Environmental clean-up
- Medical
- Chemical
- Nuclear power & fuel processing

Noninvasive Microneedle Arrays for Electrolyte Sensing enables users to monitor levels of various biofluids within the body

US Patent Pending

Sandia has created a microneedle fluidic chip that can detect and measure the amount of electrolytes within the body. Electrolyte levels are essential in monitoring the health and strength of those who are subject to extreme conditions. The device features nine sampling needles, each around 800 millionths of a meter in height. The needles puncture the skin and sample the interstitial fluid (fluids that lie between skin cells) while funneling the fluid into a channel that spreads the fluid across electrode transducers. Users can alter the electrodes to measure a variety of electrolytes simultaneously, such as sodium or calcium, on the same device. Sandia's device is non-invasive and painless, utilizing microneedles so small they cannot traumatize surrounding nerves when pressed into the skin.

Applications and Industries

- Point-of-care diagnostics
- Sports medicine
- Infectious disease treatment

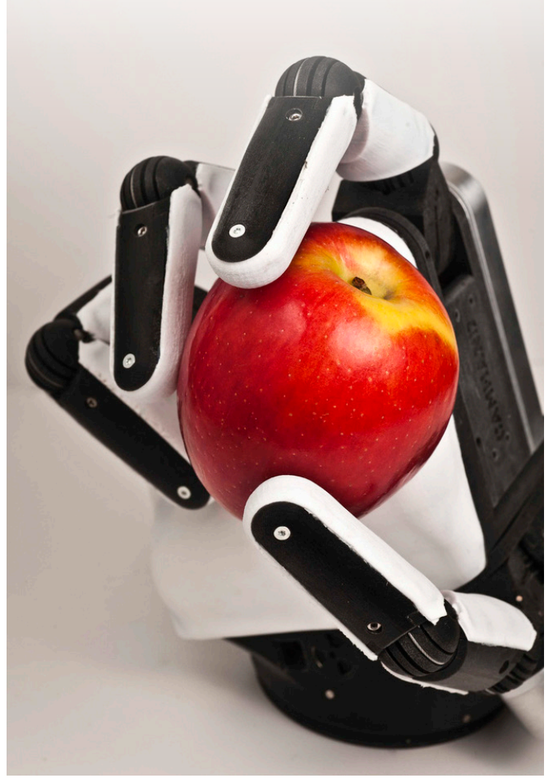
The Sandia Hand addresses challenges that have prevented widespread adoption of other robotic hands, such as cost, durability, dexterity, and modularity

US Patent # 8,936,290

Sandia has developed a cost-effective robotic hand that can be used in disarming improvised explosive devices. The Sandia Hand is low-cost, dexterous, and modular, enabling it to support a variety of applications including:

- Counter improvised explosive devices
- Countermine
- Explosive ordnance disposal
- Search and rescue
- Casualty care
- Extreme environments

The device consists of a hand frame that supports a set of identical finger modules that magnetically attach and detach from the hand frame. The finger modules contains several sensor systems, enabling the hand to perform complex manipulation tasks which are supported by several imaging systems that increase function and performance. The hand is controlled through autonomous software with semi-collaboration with human input. Sandia's system design provides users with multiple benefits, including mechanical breakaway of fingers from palm in overload conditions, a reduction in down time for customization and repair, pluggable tools, and limitless variations in palm geometry.



Industry Impacts

Entrepreneurial Seperation to Technology Transfer Program participant developed revolutionary tool commonly used to treat Lasik patients worldwide

After taking an entrepreneurial training, Dan Neal decided to license the wavefront sensor and binary optics technologies from Sandia and in 1996, dedicated his efforts into building a start-up company through Sandia's Entrepreneurial Separation to Transfer Technology (ESTT) program. Under this program, senior scientists at Sandia develop technologies from the laboratories into commercial products. Neal's company, Wavefront Sciences, used an optical sensor as the foundation of their products. The sensor allows for a variety of applications, from measuring the flatness of a silicon wafer to the characteristics of the human eye. Neal's company quickly gained momentum, landing a contract with the US Navy and Air Force to build systems that could measure supersonic seek windows for wind tunnel testing. However, he realized that one application stood out among the rest:

"Of all those applications the ophthalmic one had the largest market traction," Dan says. "We were the first to introduce a commercial product to take eye measurements that could be used to program the laser in Lasik vision correction."

Today, Neal's developments are used to improve the vision of thousands of patients worldwide. One exceptional example is the iDesign Advanced WaveScan System, which provides a comprehensive measurement of the eye structure, from the shape of the cornea to the retina. The system supplies physicians with the analysis to plan an appropriate treatment for Lasik patients. The system plays an integral part in Lasik treatment in Europe and Japan, and a diagnostic version, the iDesign DX, has been available in the US since 2013. Since its inception, the company has grown from three employees to over fifty, and is now a part of Abbott Medical Optics, a division of Abbott Laboratories. The company remains based in Albuquerque, where Neal continues to work as a research fellow.

Intellectual Property Creation & Licensing Practices

INTELLECTUAL PROPERTY CREATION

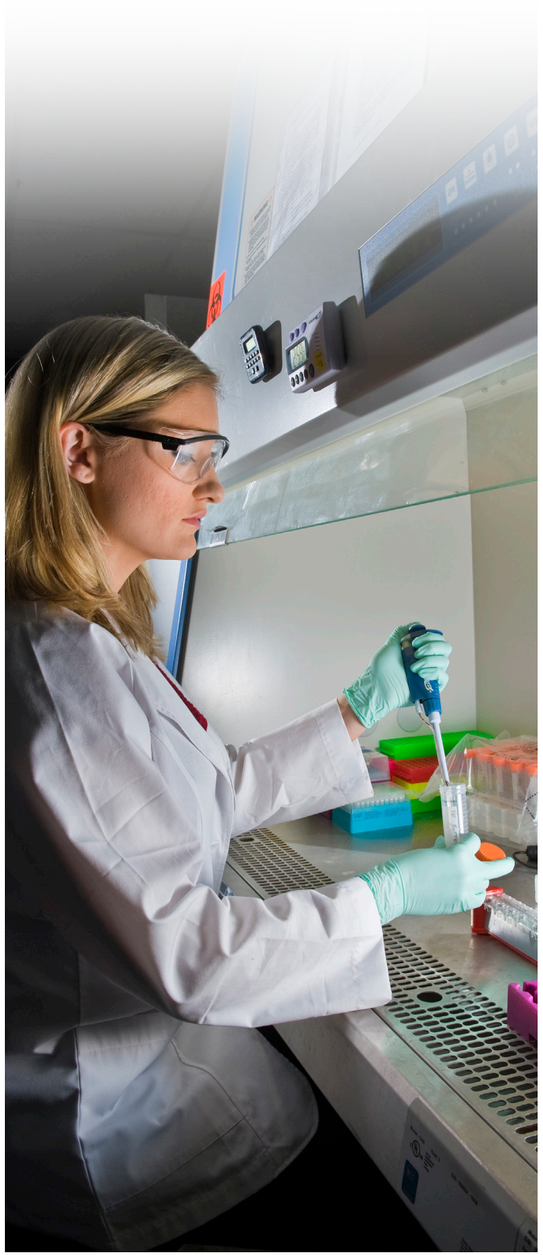
Sandia's intellectual property results primarily from R&D conducted for the government in the national security sector. Our laboratory collaborates with industry, leveraging different strengths to develop innovative technology. We perform internal R & D directed at the most challenging issues in national security, for which breakthroughs would provide exceptional value to government and industry. All totaled, Sandia has more than 1200 patents and 500 commercial copyrights, the bulk of which are available for licensing.

LICENSING SANDIA'S INTELLECTUAL PROPERTY

Sandia's intellectual property may be licensed for commercial use (internal or commercial sale), test and evaluation, or execution of a government contract. One may also secure an option on a future license. Example licenses include:

- Commercial Patent License
- Commercial Copyright License (software or design plans)
- Commercial Hybrid License (copyright and patent)
- Test and Evaluation License
- License Option
- Government Use Notice

Sandia is mandated by the Department of Energy to move its technology to the marketplace for the benefit of the U.S. economy. Given our national security focus, government is the primary customer for many Sandia licensees, but our technologies also find use in the industrial and consumer markets. Sandia issues licenses to companies ranging in size from start-ups to multinationals. Our qualification procedure considers a company's ability to bring a product to market as conveyed by their business plan, among other factors. The possibility to create a new company that can leverage our technology and achieve substantial growth is also important, given our interest in entrepreneurship.



LICENSING PRACTICES

- License term usually runs the length of the patent or copyright. Terms for Test and Evaluation licenses and License Options are limited in time.
- Financial consideration may include an upfront license fee, annual license fee, milestone fee, or running royalty, as appropriate. We seek an equitable return to the laboratory without impeding the licensee's ability to successfully commercialize the technology.
- Performance requirements may be established to insure the licensee is diligent in their commercialization plan.
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A QUARTERLY UPDATE OF AVAILABLE TECHNOLOGIES FOR INDUSTRY

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