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.

Why Work with Sandia?
Leverage World-Class Technology and Research
For more than 60 years, Sandia has delivered essential science and technology to resolve the nation’s most challenging security issues. A strong science, technology, and engineering foundation enables Sandia’s mission through a capable research staff working at the forefront of innovation, collaborative research with universities and companies, and discretionary research projects with significant potential impact.

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.

To discuss licensing opportunities, please send inquiries to: ip@sandia.gov
Or for more information, visit our website: https://ip.sandia.gov

Business Development & Intellectual Property Management
Sandia National Laboratories
P.O. Box 5800
Mail Stop 0114
Albuquerque, NM 87185-0114

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The LED Pulser allows researchers to capture images of high speed processes
SD# 13398, Patent Pending

Sandia's LED Pulser drives high-power LEDs to generate light pulses with shorter duration, higher repetition frequency, and higher intensity than is possible with commercially available LED drivers. This technology utilizes specially designed electronic circuitry that allows it to create intense pulses as short as ten nanoseconds that can illuminate extremely fast processes, such as fuel injection. The LED Pulser can emit up to four colors, each with independent timing and from a nearly coincident source area. This enables a wider range of optical applications and could lead to new imaging techniques.

Sandia engineers have already used the LED Pulser for research projects that formerly required more expensive pulsed lasers for specific measurements. It proved valuable in several research studies aimed towards designing a more efficient and cleaner engine. It proved valuable in several research studies aimed at improving engine efficiency.

By developing a composition with dissimilar cations ((Ba,Bi)(Zn,Ti)O3), researchers created competing driving forces for crystallographic distortion resulting in a highly polarizable material. In addition to the structural distortion at the atomic level, the thermodynamics associated with mixing these systems lead to chemical disorder and gradients at the mesoscopic level during thermal processing. This multi-level chemical and structural frustration results in large permittivity level values that are stable across a wide range of operating temperatures (250ºC+) and applied electric fields. In turn, Sandia's dielectric material possesses multiple advantages: 1) the material exists in a highly polarizable state; 2) results in a heterogeneous microstructure that aids in the dielectric properties; 3) high temperature resistivity; and 4) high temperature stability.

Applications and Industries
- Optoelectric (High voltage LEDs)
- Energy grid
- Alternative energy generation
- Electric trains & cars
- Defense
- Down-hole electronics
- Oil & gas

Click on the image above for a video description of the LED Pulser and how it improved research at Sandia National Labs.

Sandia engineered High Power Dielectrics can meet all operating requirements of high-reliability electronics
SD# 13051, Patent Pending

Current dielectric materials are limited and unable to meet all operating, temperature, response frequency, size, and reliability requirements needed for uncooled high-reliability electronics. To address this problem, scientists at Sandia have developed a method for producing dielectric materials using engineered chemical disorder, creating semi-conductor material that outperforms what is currently available.

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Applications and Industries
- Optoelectric (High voltage LEDs)
- Energy grid
- Alternative energy generation
- Electric trains & cars
- Defense
- Down-hole electronics
- Oil & gas

Sandia's Hybrid Piezoelectric Shaker allows industry to test devices using a wide range of vibration frequencies with increased payload
Patent# 8,408,066 & 7,851,973

Sandia's Shaker or vibration testing allows researchers and engineers to qualify products to ensure they meet standards, perform as designed and do not prematurely mechanically fail from fatigue. Traditional shakers are driven by electromagnetics or hydraulics, which limits their ability to generate high force output at higher frequencies.

By pairing traditional shakers with piezoelectric shakers, Sandia researchers have developed innovative hybrid-shakers capable of vibration testing larger payloads with much wider frequency bands than previously available. A hybrid-shaker, combining electromagnetics with piezo-electrics, can easily control vibration frequencies from 5 – 4000 Hz, where a traditional electromagnetic shaker would struggle with frequencies beyond 2000 Hz.

Beyond combining piezoelectric shakers with traditional shakers, Sandia researchers have also employed the use of piezoelectric shakers on centrifuges to provide the most realistic ground based inertial tests possible. This vibrafuge technology has proven extremely valuable to many customers, helping understand product performance under more realistic test environments.

Applications and Industries
- Multiple Degree of Freedom (MDOF) testing
- Automotive
- Aerospace
- Electronics
- Military and defense

Click on the image above for a video description of the Hybrid Piezoelectric Shaker and how it improved research at Sandia National Labs.
**Multifunctional Platelet Composites for Tin Whisker Mitigation**

Prevents tin whiskering and enhances thermal conductivity and dielectric properties in electronic systems

**SD#13208, Patent Pending**

In order to comply with the Restriction of Hazardous Substances (RoHS) directive, pure tin is replacing lead-tin alloys in commercial electronic devices. Unfortunately, tin can grow whiskers that can lead to electrical short circuits or metal vapor arcing, both of which threaten the long-term reliability of electronic systems for weapons, satellites, military, and automotive applications and can cause critical systems to fail catastrophically. A current method of whisker mitigation utilizes coatings based on both glassy or rubbery unfilled polymers, but such coatings are not impenetrable to tin whiskers. Seeking a more reliable method of whisker mitigation, Sandia researchers developed a composite coating comprised of platelet-shaped particles such as Ni or MgF2 coated Ni/Al dispersed in silicone or epoxy. When the platelets are oriented with their directors normal to the tin-plated surface, they create a multilayer barrier resembling that found in nature (e.g., abalone shell). Platelet orientation is easily controlled using surface modification to prevent the polymer from wetting the platelet surface, extrusion, and applying magnetic or electrical fields. Platelet-filled composites vastly outperform conventional unfilled polymers. In tests conducted in a thermal cycling environment known to promote whisker growth, commercial capacitors coated with the Sandia composite exhibited no signs of whisker penetration, whereas those coated with conventional polymers showed whisker penetration. In addition to its increased penetration resistance, Sandia’s composite enhances thermal conductivity and dielectric properties, and reduces out-of-plane gas permeability.

**Applications and Industries**

- Consumer electronics
- Electronic weapons systems
- Satellites
- Defense
- Automotive

**Environmentally-friendly Biofouling Mitigation Coatings**

Prevent the buildup of biofilm on important marine structures

**SD#12087 & 13195, Patents Pending**

Marine biofilm can be detrimental to the function and longevity of equipment exposed to water, such as ships and hydrokinetic energy devices. For over 2000 years, toxic coatings have been applied to hulls of ships to prevent the accumulation of marine bacteria and microalgae. While effective, toxic chemicals from these paints eventually leach into the surrounding environment, causing negative environmental impact. The need for an environmentally-friendly biofouling solution has increased as there has been a strong push to outlaw these traditional metal-based paints. Sandia researchers focused on developing coatings that are as effective as current coatings, without the harmful effects to the marine environment. One team of researchers developed zwitterionic coatings that create a barrier between the coated surface and marine bacteria/microalgae by interacting with the water molecules and organizing them in a way that prevents organisms from attaching to the surface, rather than killing the microorganisms. The coating can be applied as a self-polymerizing monomer based on a siloxane attached to a zwitterionic pair, or in a two-step process wherein the surface is first sprayed with a polysulfone and then treated with dimethylaminobutyric acid (DMABA). The DMABA reacts with the polysulfone, creating zwitterionic groups, thus creating a surface in which microorganisms will not stick. A second coating was developed using sulfonium ions, known for their antimicrobial/antibacterial properties, incorporated into a hydrophobic polymer. The ions in this polymer penetrate cell walls, killing microorganisms before they can adhere to the surface. In addition to its antimicrobial properties, this polymer acts as a foulant release coating when exposed to UV light or heat. The UV light/heat changes the molecule compositions in the coating, allowing for easy removal of any foulant. This switchable coating can then be returned to its antimicrobial state. Sandia’s biofouling coatings are easy to apply, offer superior ease in foulant removal, durable and environmentally-friendly.

**Applications and Industries**

- Hydrokinetic energy
- Marine
- Defense
- Deep-sea drilling
- Shipping industry
Solar Glare Hazard Analysis Tool (SGHAT v. 3.0) is an easy to use web-based tool that can optimize performance of solar installations and prevent solar glare

**SCR#1567.2**

With growing numbers of solar energy systems being proposed and installed throughout the United States, the potential impact of glare and glare from photovoltaic modules, concentrating solar collectors, receivers, and other components is receiving increased attention as a potential hazard or distraction for pilots, air-traffic control personnel, motorists, and residents. Hazards from reflection of solar radiation from solar power plants include the potential for permanent eye injury (e.g., retinal burn from concentrated sunlight) and temporary disability or distractions (e.g., after-image). Visual impairment can be mitigated by surfaces (e.g. anti-reflective coating, texturing), and locations of solar installations that not only mitigate the impacts of glare, but also optimize energy production. It also has the ability to model fixed, single-axis, and dual-axis photovoltaic tracking systems.

Following the success of SGHAT v. 2.0, Sandia researchers developed a newer version with increased functionality and improved performance. SGHAT v. 3.0 features automated optimization to select PV configurations (orientation and tilt) that mitigate glare while maximizing annual energy production. The built-in flight path tool has been enhanced to evaluate continuous flight paths rather than discrete points along a flight path. It also has the ability to analyze glare from vertical surfaces, such as glass buildings.

The calculations and methods are based on analyses, test data, database of different photovoltaic module surfaces (e.g. anti-reflective coating, texturing), and models developed over several years at Sandia to evaluate ocular hazards. The results are presented in a simple easy-to-interpret plot that specifies when glare will occur throughout the year, with color indicating the potential ocular hazard.

Hedgehog™ Contaminant Removal System is a small and cost efficient remediation tool for small-scale water sources

**US Patent #7,514,004**

Sandia’s Hedgehog™ is an in-tank recirculating treatment system designed to reduce the levels of a variety of organic and inorganic contaminants in water storage tanks. The Hedgehog™ works by utilizing a recirculation pump that continually sends water through a treatment module to reduce the levels of contamination.

Originally developed for arsenic decontamination, this in-tank filtration device has been extensively tested on small water systems (~100 connections or less) with ambient arsenic (As) levels of 11-25 ppb. The smaller scale, greater efficiency, and reduced cost of this filtration system make it a viable option for small tank owners and communities. The annual cost for Hedgehog™ is approximately 1/3 of the Granual Iron Media (GIM) option. Estimates indicate similar results for smaller scale, greater efficiency, and reduced cost of treatment.

Large communities and cities have the resources to deal with large-scale water remediation using large infrastructure and manpower. Hedgehog was designed for smaller communities that need access to clean drinking water but do not have the resources of larger communities. The Hedgehog™ does not require costly filtration galleries, it can be added to any well, water tower or water containment system.

**Applications and Industries**
- Water treatment in small communities
- Public safety
- Municipalities
- Schools
- Offices
- trunk charging batteries
- Water treatment in small communities
- Public safety
- Municipalities
- Schools
- Offices
- Trickle charge batteries
- Air, water and land-based vehicles
- Oil rigs
- Heavy machinery
- Bridges and other architectural structures subject to vibrations

Harvest mechanical energy and convert it to electrical energy using Sandia’s Vibrational Energy Converters

**US Patent #7,498,681; 7,948,153**

What if the vibration caused by walking across a bridge generated electrical energy? At Sandia, researchers have learned to exploit the ambient environment as an inexhaustible source of energy. Our vibration energy harvesters are modeled and designed based on velocity-damped resonant generator (VDRG) principles.

One design utilizes a planform tapered piezoelectric bimorph as a spring support for a sense mass as well as the transduction mechanism for converting mechanical to electrical energy. The planform taper allows for maximum transduction efficiency.

For high temperature environments, another generator designed using magnetic-induction based energy conversion was developed using a magnet that is movable through a gap in a ferromagnetic circuit. The magnet is attached to the frame using a flexible coupling that aligns the magnet as it moves through the gap in the circuit. This technology allows high-level magnetic flux changes to be generated at a resonant frequency from low-force, low-amplitude oscillatory motion inputs.

Applications and Industries
- Persistent, unattended remote operation of microelectronics
- Trickle charge batteries
- Air, water and land-based vehicles
- Oil rigs
- Heavy machinery
- Bridges and other architectural structures subject to vibrations
Sandia National Labs develops computing solutions to address some of the nation’s most complicated national security issues. By releasing some of this software as open source, we are fostering collaborations and streamlining the licensing process. Below are some of the most recent software to be released as open source. All software highlighted in this section is available for immediate download.

Click on the software titles for download information.

**minimega**

**SCR#1592**

minimega is an emulys® platform that creates testbeds for networked devices. It allows users to test and evaluate new applications on a virtual network prior to introducing them to an actual network. minimega is equipped with easily deployable tools to facilitate bringing up large networks of virtual machines including Windows, Linux, and Android. It also includes tools for simple cloud management. In the latest version, minimega includes testbeds for mobile platforms.

**Python GSTF Implementation (PyGSTi)**

**SCR#2018**

PyGSTi is a system-independent diagnostic and benchmarking tool for developers of qubit devices. This software generates a list of experiments to perform then processes the experimental data in order to estimate and analyze qubit gates. PyGSTi can be used to compute qubit metrics (e.g. fidelity, trace distance, and diamond norm), as well as diagnose the cause of imperfect qubit performance.

**UseLATEX.cmake v. 2.0**

**SCR#1738**

This software simplifies the process of building LaTeX documents. The “boilerplate” required to build targets in encapsulated into an easy-to-call CMake function. The function also provides several arguments and options to define multiple input sources and build elements (e.g., bibliographies, indexes, and glossaries).

**PV_Lib**

**SCR#1507**

PV_Lib provides a set of well-documented functions for simulating the performance of photovoltaic energy systems. This software has the ability to compute solar position and to estimate irradiance in the PV system's plane of array, cell temperature, PV module electrical output, and conversion from DC to AC power. Also included are functions that aid in determining parameters for module performance models from module characterization testing. This toolbox is available in Matlab and Python.

**GloVe C++**

**SCR#2023**

The GloVe natural language processing algorithm learns the meaning of words from their context, with unprecedented ability, from a large body of text. For instance, it is able to understand real analogies, such as “king is to queen as man is to woman” and to uncover other complex relationships that even experts may not be aware of. The algorithm is useful for learning the real meaning of a huge body of unstructured text, and is useful for a variety of cybersecurity applications. However, achieving the performance necessary to scale GloVe to big data is a challenge since it is designed to run on conventional computer processors. GloVe C++ is a high performance implementation that can take full advantage of modern “vectorized” computers, including Graphics Processing Units (GPU) and Intel Xeon Phi accelerators. This will enable researchers to use GloVe to solve problems that could not previously be tackled on conventional computer processors.
**Sandia’s 2015 R&D 100 Award Winners**

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**CO2 Memzyme**

With the increasing concern over the effect of global warming, Sandia researchers developed a flexible substrate that contains a layer of enzymes dissolved in water that have the capability to neutralize CO2. Designed to withstand high temperatures, when placed in a power plant flue, it has the capacity to neutralize 90% of CO2 emissions.

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**Silicon Carbide JFET Switch**

The JFET Switch is a low-loss power switch based on a novel silicon carbide junction field-effect transistor which will improve the efficiency of next-generation power conversion systems used in energy storage, renewable energy, and military applications, as well as data center power distributions. In collaboration with United Silicon Carbide, Sandia developed a 6.5 kv rated enhancement mode transistor using silicon carbide in order to withstand temperatures up to 200º C. This technology allows energy generated by green technologies to be stored and converted for use in an efficient manner, making it more feasible for public use.

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**Integrated Circuit Identification (ICID)**

This technology can authenticate integrated circuits (IC), detect counterfeit electronics and verify individuals’ identities using physically unclonable functions (PUFs). PUFs are the unique small variations, caused during chip manufacturing, that are easily measured yet impossible to reproduce.

By carefully measuring these manufacturing variations, a unique digital id can be created. The IC can then be authenticated using a challenge and response protocol. The challenge and response protocol uses a private key extracted from the PUF measurement in order to decrypt the challenge issued to it. ICID provides a method to track and verify ICs throughout their lifespan.

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**Lightweight Distributed Metric Service (LDMS)**

Lightweight Distributed Metric Service (LDMS) is the first platform-independent monitoring tool providing near-real-time, synchronized, high fidelity, system-wide awareness down to one-second-or-less intervals across tens of thousands of nodes without adverse impact on running applications. LDMS data is unique in scope and fidelity, enabling fundamentally new insights about, and responses to, system and application performance. This software is an ideal tool for system administrators, developers, and the high performance design community.

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**Every year R&D 100 magazine receives submissions for the most innovative technology from top universities, laboratories, researchers and developers across the world. Awards are presented to researches who have developed the year’s 100 most outstanding advances in applied technologies. This year five Sandia developed technologies received this distinct honor.**

Click on pictures for additional information
Synthesized Porphyrins are light-absorbing molecules that can be used to make nanodevices with a wide range of optical and electronic properties

Patent #7,223,474

Porphyrins are a class of organic molecules with light-absorbing properties, which plays an active role in photosynthetic proteins and light-harvesting nanostructures.

Sandia developed a method of synthesizing metal nanostructures composed of porphyrins. These nanostructures have wide applicability, especially in the realm of electronics due to advantages such as increased surface area, low density, low material cost, and special optical properties. Sandia’s method of growing nanoshells requires a photocatalytic reduction of metal ions at the interface between the dispersed and continuous phases of an emulsion. The emulsion droplet serves as a template for hollow-nanoshell growth. The photocatalytic reaction is carried out by a specialized porphyrin and causes subsequent growth of the nanoshells. The size of the shell is controlled by the size of the emulsion droplet, while the wall thickness depends on metal ion availability.

Furthermore, Sandia also created a nickel-porphyrin derivative that can be used in optical memory applications that require fast-switching times and long data-retention times. The nickel-porphyrin derivative is comprised of a lower-energy-state and high-energy-state isomer and suspended in a gel or solvent matrix. The energy states are analogous to “on” and “off” switches, providing the user with the ability to controllably switch from one energy state to another, making it appealing for molecular-scale optical memory applications.

Applications and Industries
- Electronics
- Microelectronics
- Photonics devices
- Chemical sensors

Smart Trigger Logic for Focal Plane Arrays captures light intensity data values even with continuous exposure to light

US Patent #8,681,248

Conventional charge-coupled devices and other photoelectric image sensors capture image data. The sensors are made into a grid containing light-sensing pixels; each grid can range anywhere from tens of pixels to millions of pixels. These light-sensing pixels are especially useful for applications such as cameras, however, continuous exposure to light (i.e. video camera) can cause difficulties in processing and transferring data from the pixels since the transmission bandwidth is limited.

To address the problem, Sandia developed an electronic device that can effectively collect and transmit focal plane array data. The current invention is comprised of a memory configured to receive light intensity data values from focal plane array pixels, in addition to a processor that analyzes the data to determine which light values correspond to which triggered pixels.

Sandia’s invention can be scaled to use in computer systems to effectively analyze the light intensity data and can be practiced in a variety of networked computing environments, ranging from personal computers to multi-processor systems, allowing for ease of use.

Applications and Industries
- Industrial hazard detection
- Chemicals

Sandia’s Capacitive Chemical Sensor provides autonomous, selective and sensitive chemical sensing with little to no maintenance

US Patent #8,736,000

Utilizing parallel-plate technology, Sandia has developed a capacitive chemical sensor that can detect chemicals in a gas or liquid environment. The chemical sensors have the ability to provide autonomous, selective and sensitive chemical sensing with little to no maintenance. Switching the dielectric films of the sensor allows the use to tailor the sensor to chemically react with different target analytes, which can be observed through changes produced in the capacitance of the sensor.

Like the conventional chemical preconcentrator, the sensor adsorbs target analytes but has the added function of being able to determine the relative amount and type of the adsorbed species. The advantages of Sandia’s sensor include optimized or reduced analysis time of the total-system and assurance that analyte concentrations are within the systems detector’s linear regime, all the while protecting the system from overloading.

Applications and Industries
- Industrial hazard detection
- Chemicals
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 1600 patents and 550 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 remains an area of significant interest for Sandia.
INNOVATION MARKETPLACE
A QUARTERLY UPDATE OF AVAILABLE TECHNOLOGIES FOR INDUSTRY

To discuss licensing opportunities, please send inquiries to: ip@sandia.gov
Or for more information, visit our website: http://ip.sandia.gov

Business Development & Intellectual Property Management
Sandia National Laboratories
P.O. Box 5800
Mail Stop 0114
Albuquerque, NM 87185-0114