Basic Research in

Science and Technology

Sandia pushes frontiers of knowledge to meet the nation's needs, today and tomorrow

Sandia National Laboratories' fundamental science and technology research leads to greater understanding of how and why things work and is intrinsic to technological advances. Basic research that challenges scientific assumptions enables the nation to push scientific boundaries. Innovations and breakthroughs produced at Sandia allow it to tackle critical issues, from maintaining the safety, security and effectiveness of the nation's nuclear weapons and preventing domestic and international terrorism to finding innovative clean energy solutions, developing cutting-edge nanotechnology and moving the latest advances to the marketplace. Sandia's expertise includes:

Geosciences: Geosciences focuses on multi-scale, multiphysics approaches to understanding natural systems, "engineering the earth" with sensing and drilling technologies and characterizing geomaterials in extreme environments, primarily temperature and pressure. Research in such vital areas as climate and energy security, disaster response and clandestine underground facilities includes experimental and molecular-scale modeling of water-rock interactions, developing and applying 3-D seismic imaging techniques, experimental and computational geomechanics and studying fluid flow through complex geomaterials.

Biosciences: The nation increasingly looks to biology to provide solutions to national security challenges in energy and biodefense. Sandia is developing technologies to characterize unknown pathogens in clinical samples. Sandia employees have developed proto-cells that carry drugs to knock out targeted cancer cells. Bioenergy researchers are working to develop clean, renewable and efficient sources of domestic energy, such as biofuels from algae, to reduce the need for foreign oil and boost economic and military strength.

Sandia National Laboratories

Exceptional service in the national interest

Microsystems and Nanosciences: Sandia pioneered work in microsystems in the 1960s with the invention of the laminar flow clean room. It went on to establish leadership in radiation-hardened integrated circuits, institute revolutionary work in super-lattices that deliver the framework for custom semiconductor materials and develop groundbreaking capability in novel microsensors. Sandia is developing microscale- and nanoscale-enabled systems that will redefine solutions for sensing, communication, computing and energy conversion.

Engineering Sciences: Engineering sciences uses advanced computational simulation to characterize complex physical phenomena and the behavior of engineered systems. State-of-the-art experimental facilities, including combustion research and major environmental test facilities, provide both data to validate computational models and test beds to assess performance under various conditions. Engineering sciences analysis is a critical part of programs for nuclear weapon modernization, energy efficiency and defense systems.

Materials Science: Researchers work to predict how materials will behave under a variety of conditions to improve the understanding of today's materials and anticipate what might be on the horizon. Sandia's materials science efforts use sophisticated tools, including microelectronics silicon and compound semiconductor fabrication labs, the state-of-the-art aberration-corrected scanning transmission electron microscope, the Thermal Spray Research Laboratory and the Ion Beam Laboratory.

Jason Wheeler demonstrates a liner aimed at helping prosthetic limbs fit better. Sandia's Intelligent Systems, Robotics, and Cybernetics group is developing the sensor system technology to tell what's going on in a limb and to automatically accommodate those changes.

Sandia researcher Vitalie Stavila inserts a substrate patterned with electrodes into a temperature-controlled liquid-phase reactor for depositing metal-organic framework (MOF) thin films. Sandia's research team plans to combine MOFs with dye-sensitized solar cells, a technique it believes will lead to advancements in photovoltaic technology.

Radiation and High Energy Density Sciences: Sandia is home to the Z facility, the world's largest lab-based pulsed-power facility. X-ray power from Z's firing is more than 100 times larger than the power produced by all of Earth's electrical power plants, though only for nanoseconds. Controlled implosions create extreme environments that reach the pressure and temperature of the sun, providing data for astrophysicists simulating stellar behaviors, scientists looking for alternatives to explore nuclear weapons science and researchers who think pulsed power is the path to fusion energy.

Computer and Information Sciences: Sandia is working on the next generation of computers, the so-called exascale, capable of a million trillion mathematical operations per second. The laboratories' impressive computing history includes Paragon, the first parallel processing computer; ASCI Red, the first teraflop computer; and a then-revolutionary supercomputer design called Red Storm that became the most reproduced supercomputer ever.

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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