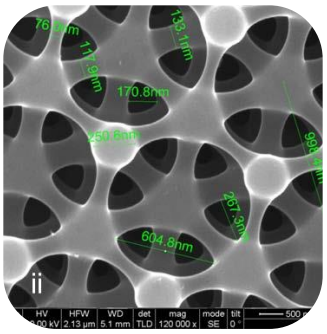
Exceptional service in the national interest

Sandia National Laboratories

Biosensors for Environmental Sensing and Medical Diagnostics



Sandia's Biosensors and Nanomaterials Department conducts research and development at the interface between biology, synthetic chemistry, and surface science to deliver prototype solutions in applications ranging from environmental sensors to medical diagnostics. Sensor development includes discrete sensors and multiplex sensor arrays based on piezoelectric, fiber-optic, micro-optic, electrochemical, biochemical, and microimpedance transduction.

Employing both biological and nanoscale phenomena, we have demonstrated novel sensing mechanisms to address a broad range of applications. We incorporate our sensor technology into handheld and autonomous microsensor systems with field deployment as our ultimate goal. Our technology, spanning the readiness scale from basic research to prototype devices, has been developed to meet the needs of numerous federal agencies and commercial partners.

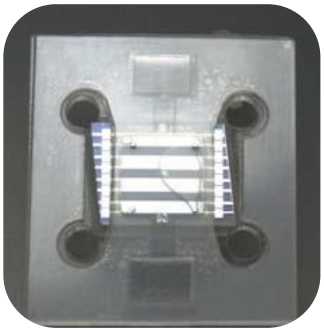
Sandia's microsensor core competencies at Sandia include:

- Sensor and sensor arrays R&D based on piezoelectric, fiber-optic, micro-optic, electrochemical, biochemical, cell-based, and impedance devices;
- Synthetic chemistry efforts including nanoparticle growth, surface functionalization, and molecular electronics;
- Microfluidic sample preparation and microfluidic packaging;
- Biomimetic and bio-nano hybrid technologies.
- Product development and fielding of sensor systems.

Sandia National Laboratories conducts research and development at the interface between biology, chemistry, and physics to anticipate the needs of national security applications and deliver autonomous, integrated prototype solutions ranging from environmental sensing to medical diagnostics.

For additional information, visit our website at:

www.sandia.gov/mstc/



MICROSYSTEMS SCIENCE, TECHNOLOGY & COMPONENTS

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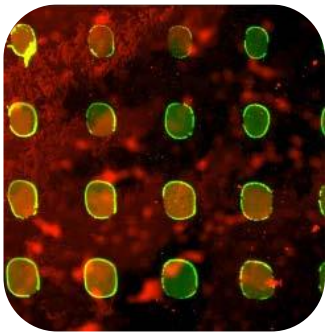
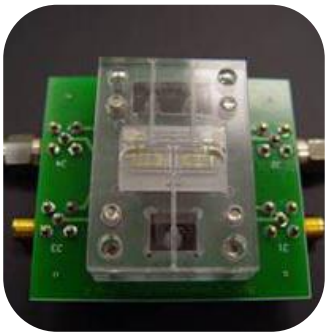
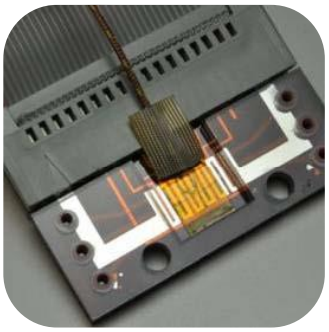






Above: Acoustic Wave Sensors provide "ultrasonic bath on-a-chip" capability.

Left: Electrochemical Arrays, microfluidic package integrates sensors and valves.

Acoustic Wave Sample Preparation

Our miniature acoustic lysing system provides front-end sample preparation for environmental bio sensing and medical diagnostics by rapidly and efficiently releasing nucleic acids and proteins from cellular samples. The "ultrasonic bath on-a-chip" technology provides a fast and reagent-less method to produce a continuous source of lysate without harsh chemical agents, mix reagents in microfluidic channels, and selectively remove protein contaminants. When compared to commercial lysing instruments, our prototype micro fluidic system provides higher efficiency, takes less time, consumes less power, and occupies a much smaller footprint.

Electrochemical Arrays

Electrochemical sensors utilizing selectively functionalized electrode arrays allow for multianalyte detection and substantially increase confidence in the sensor output. These microsensor arrays are packaged in a simplified, handheld system that does not require additional reagents, and are highly multiplexed to detect both chemical and biological agents including DNA, proteins, bacteria and viruses.

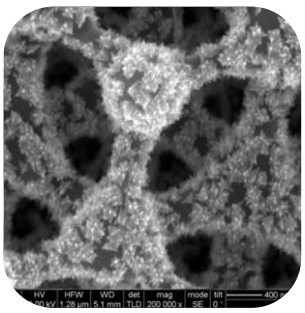
3D Electrodes with Catalytic Nanoparticles

Catalytic nanoparticles can improve the speed and sensitivity of electrochemical sensors while providing a high surface area for reactions to take place and increased loading capacities for biomolecules. Highly faceted palladium nanoparticles can be deposited into ordered 3D porous carbon electrodes to create an active surface that takes advantage of the catalytic properties of the nanoparticles and the high mass transport environment of the porous carbon for greater diffusion of analytes. These electrodes can be used as a non-enzymatic glucose sensor and for the detection of other electroactive molecules as well as in conjunction with standard antibody assays for the detection of proteins and nucleic acids. The main advantage is that the sensor can be tailored for specificity by controlling the nanoparticle, shape, size, and composition simply by adjusting preparation conditions.

Cell-Based Biosensors

Molecular biology and genomic-scale technologies are being used to create sensor arrays that utilize living cells as active sensing elements. These biosensors use innate sensing capabilities within living organisms to detect chemical and biological agents for environmental sensing applications. We are generating cell lines that uniquely fluoresce in response to a variety of target agents. In addition these cells will be patterned /printed onto a variety of substrates including MEMS fluidic architectures, or micro-robots for remote sensing.

Right: Catalytic Nanoparticles



Below: SH-SAW Biosensor Array

SH-SAW Arrays

Shear horizontal surface acoustic wave (SH-SAW) sensors are well suited for the detection of biological agents in liquid environments. These devices have the dual advantages of high sensitivity, down to picograms/cm^2, and high specificity, conferred by biological receptors such as antibodies, peptides, and nucleic acids. We have demonstrated the detection of bacteria, viral particles, and proteins with these sensors. Handheld biodetection systems incorporating these microsensors have been developed.

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

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