

# Portable Chemical Sensors for Environmental and State of Health Monitoring

Emerging nano technologies are transforming microsensor research and development, a key enabler of Sandia's national security mission. By emphasizing handheld and autonomous technology, we are developing novel biological and chemical microsensor technologies across a range of technical maturity that has applications for numerous federal agencies and commercial partners.

## **$\mu$ Chemlab™**

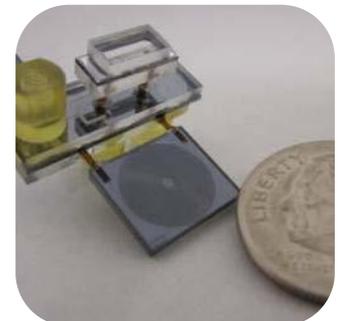
Sandia's  $\mu$ Chemlab™ is the basis for several different chemical detection and identification systems that have been deployed for monitoring chemical warfare agents (CW), toxic industrial chemicals (TICs), and halogenated organics produced during municipal water treatment, among other applications. These systems are designed to be both more portable and provide more rapid analysis than standard laboratory instruments, with minimal user training requirements. The  $\mu$ Chemlab™ uses a 3 stage design incorporating a sample preconcentrator (PC) gas chromatography column (GC) and a detector. The PC and GC are microfabricated by techniques similar to those used in electronic microchip production. Several different detectors are employed depending on application, ranging from microfabricated surface acoustic wave (SAW) mass-sensitive arrays through ionization detectors like the ion mobility spectrometer (IMS) and selective Nitrogen- Phosphorus Detector (NPD) shown above. Different surface coatings on the PC and GC can be combined with different detectors to optimize the system for analysis of different target compounds. Sandia's Micro Gas Analyzer (MGA) extends capabilities into an ultra-portable application for the warfighter and other personnel, which is funded by DARPA and DTRA.

For additional information, visit our website at:

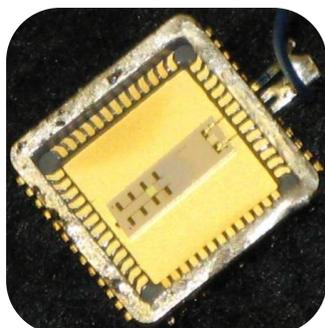
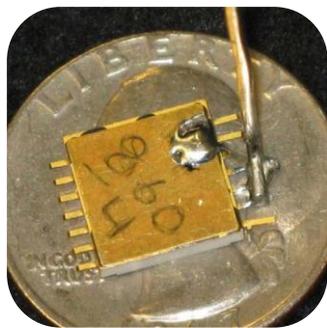
[www.sandia.gov/mstc/](http://www.sandia.gov/mstc/)



*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.*



# MICROSYSTEMS SCIENCE, TECHNOLOGY & COMPONENTS



**Above: Passive Wireless Surface Acoustic Wave Sensors.**

**Left: 100 MHz Parker-Hannifin THM Sensor.**



## Passive Wireless Surface Acoustic Wave Sensors

We have developed surface acoustic wave (SAW) based passive wireless sensors for measurement in environments of extreme temperature (550°C), extreme acceleration (250 gs), and radiation. Wireless passive sensors can be applied to the measurement of chemical and physical phenomena in environments where semiconductor-based sensors cannot survive, or in difficult to access locations where maintenance is impractical. Other types of passive sensors are based on semiconductor technologies that cannot survive and function above a maximum of 200°C due to materials issues. Our devices can routinely reversibly cycle up to 450°C with no reduction in performance, and will work for single shot tests up to 550°C. We have successfully demonstrated wireless temperature sensing under pressure, as well as at high temperature in a furnace.

## 100 MHz Surface Acoustic Wave (SAW) Sensors for Measurement of Trihalomethanes (THMs) in Surface Water

Using nano-porous carbon (NPC) films coupled with SAW sensing at 100 MHz, we have demonstrated reliable and reproducible detection of THMs in water. We have successfully transferred 100 MHz SAW technology to Parker-Hannifin Corporation, enabling a new product for the measurement of THMs with sensitivities down to an EPA mandated 10 ppb. The commercial product based on Sandia's 100 MHz SAW technology allows water utilities to rapidly (~30 min) access the quantity of THM in the water and vary the concentration of purification chemicals such as chlorine in nearly real-time, allowing the reduction of the quantities of THM and allowing money-saving reduction of chemicals in the water. The unit combines all the necessary system features (purge, trap, separate, and detect) using a low-cost, small, light-weight sensor based on mature SAW device technology, and is greatly improved with highly sensitive, reliable, reproducible, and thermally stable nano-porous (NPC)-sorbent coatings.

## Microsampler with Integrated Microvalve

Sandia has developed a miniature air sampler that enables the collection of inert atmospheric samples without contamination. This capability enables samples to be taken in the field, and then sent in pristine condition to a laboratory for more detailed analysis. The Sandia phase-change micro-valve sensor is light, cheap, tough, inexpensive to fabricate and simple to operate. It takes in gas in seconds through a tiny hole about the diameter of three human hairs. The hole closes when a tiny, low-energy hotplate on the canister's surface melts shut the alloy through which the hole passes, sealing it. Because the container doesn't outgas internally, the trapped sample remains uncorrupted until analyzed in the laboratory. The miniature sensor's simplicity enables it to survive in extreme temperature and atmospheric conditions, meaning it could be used in many applications including travel in unmanned aerial vehicles (UAVs), as unmonitored cargo in atmospheric balloons, or sent down boreholes for underground analysis.



**Microsampler with Integrated Microvalve**

