μChemLab™: Chem Detector

A hand-held instrument for chemical analysis

Fact Sheet

The gas-phase μChemLab is a handheld chemical analysis system that incorporates microfabricated components for handling, separation, and detection of chemical warfare agents and toxic industrial chemicals. It collects and concentrates samples, separates them via a miniaturized gas chromatography column, and detects the constituent components using an array of surface acoustic wave sensors.

Consuming just 4 watts of power and occupying just 64 cubic inches to fit comfortably in the hand, the unit provides rapid and discriminating analyses. By offering vastly improved speed and simplicity compared with traditional laboratory devices, micro-analytical systems such as μChemLab promise to revolutionize a number of fields, including food processing, health care and chemical and biological weapons defense. The prototype consists of two parallel analysis channels, each having a preconcentrator, a gas chromatographic column and a detector array.

Collection/Concentration

A preconcentrator unit is tailored with various coatings to select analytes of interest from an inlet gas stream. The analytes are adsorbed onto a film-coated membrane. Microporous thin-film adsorbent layers provide sample collection and concentration of 10 times or better in only 30 to 60 seconds.

The membrane supports a patterned metal heater that releases the analytes when energized. This "thermal pulse" ejects the analytes into the separation stage.

Separation

The analytes are next separated in two gas chromatograph columns that have been deeply and narrowly etched into a silicon wafer. To provide distinct separation profiles, each column is coated with stationary phases of differing polarity. Each one-meter column is spiraled to occupy a compact square centimeter of space. Coatings in the columns retain analytes for different lengths of time. The analytes emerge in a sequence of distinct peaks whose pattern indicates the identity of each constituent.

The gas-phase μChemLab system packaged in a battery-powered hand-held unit for portable field use.

Detection

Detection is achieved using an array that measures the mass of the constituents as they exit the gas chromatograph column and impinge on a quartz crystal bearing a coated surface acoustic wave detector. When the coating absorbs the compound, a wave traveling the surface changes frequency, much

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μChemLab™

like a drum will change tone if a hand is placed on the vibrating surface.

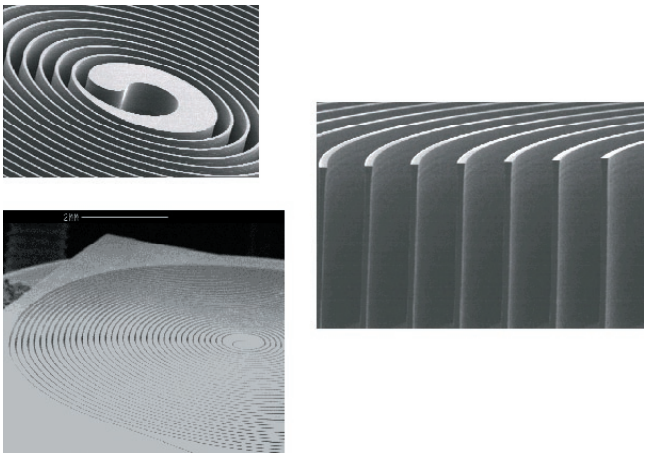
The analysis time from start to finish is just seconds to minutes, and detection sensitivities of 10 – 100 ppb have been demonstrated.

Integration

The μChemLab components are mounted on a printed circuit board that carries both electrical and gas interconnects. Two complete analysis systems on the board allow parallel analysis of components under differing conditions, increasing the resolution.

Status

The gas-phase μChemLab has demonstrated reliable, reproducible results over many trials both in the laboratory and in the field. It has been successfully tested with actual chemical warfare agents at Edgewood Chemical and Biological Center, where five nerve agents and two blister agents were detected at low levels. Results showed very little interference from humidity, hydrocarbons and other common chemicals. The gas-phase μChemLab has also been used at the Nevada Test Site to monitor field testing of chemical weapons agent simulants that were explosively dispersed. These tests proved that the instrument could operate in a very sensitive manner (parts per billion detection) in a very dusty field deployment.



The gas chromatography columns consist of high-aspect-ratio micromachined channels spiral-etched in silicon.

Current efforts have expanded the capabilities of the μChemLab to detect a wide range of toxic industrial chemicals. Instrument improvement is taking place in parallel with process development. Several projects have successfully concluded, including process analysis for the petroleum and pharmaceutical industries. Future plans include combining the gas-phase capabilities with a liquid-phase electrophoretic analyzer being developed at Sandia National Laboratories in Livermore, Calif. This should place the power of a fully equipped analytical laboratory into the hands of a trained end-user, such as an emergency responder reporting to the scene of a suspected chemical or biological attack.

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For more information contact
Sandia National Laboratories
Richard Cernosek at (505) 845-8818
rwcerno@sandia.gov