μChemLab™

Fact Sheet

A Chemical Analysis Lab on a Chip

Sandia National Laboratories is developing fully self-contained, portable, hand-held chemical analysis systems incorporating “lab on a chip” technologies.

Our μChemLab™ systems utilize microfabricated substrates to provide sensitive devices with fast response times in a low power, compact package.

Using microfabrication techniques, we can construct a parallel separations architecture in which a variety of different separation and detection systems are employed simultaneously to provide a retention time fingerprint for each target analyte. This fingerprint is used to provide highly accurate chemical identification even in the presence of complex background species.

Currently, devices are being developed and tested for the detection of chemical warfare agents and protein biotoxins.

Chemical Agent Detection

The chemical agent device employs three cascaded components—sample preconcentration, gas-phase separation and surface acoustic wave (SAW) detection—to provide high sensitivity and chemically selective detection.

Microporous thin film adsorbent layers are used to provide selective sample collection and concentration of 100x or better for target analytes in only 30-60 seconds.

Two miniature 1-meter long gas chromatographic columns are used to separate the collected analytes in time, providing a retention time as an additional indicator of the chemical species. To provide distinct separation profiles, each column is coated with stationary phases of differing polarity.

Detection is achieved using an array of SAW devices coated with chemically selective coatings to provide sensitive detection of the target analytes as well as to provide an array response pattern that can be used to identify the chemical being detected. Detection sensitivities of 10-100 ppb have been demonstrated in the integrated device.

Protein Biotoxin Detection

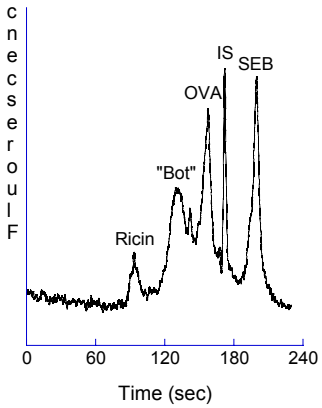
The biotoxin device utilizes micro-scale liquid-phase chromatography and capillary electrophoresis together with laser-induced fluorescence (LIF) detection to provide sensitive analyses at low nanomolar concentration levels.

A two-channel device has been developed and tested which utilizes capillary zone electrophoresis and capillary gel electrophoresis to provide orthogonal analyses of protein mixtures.

Proteins are tagged with a fast-reacting fluorescent dye,

The components for the gas-phase chromatograph used for detecting chemical agents.

separated in a parallel architecture, then detected by miniature blue diode LIF. On-board data processing identifies the presence of biotoxins such as ricin and staphylococcal entertoxin B.



Separation of protein biotoxins by capillary zone electrophoresis using the liquid-phase device.

Microfluidics

To provide miniaturized chemical analysis systems, we must reduce the size of all the components including the electronics and the fluid handling systems.

For liquid-phase separations, we use electric fields to manipulate nanoliter volumes of fluids in microchannels. We have successfully miniaturized high voltage power supplies and control systems to produce controllable electrokinetic flows in a portable device.

Electrokinetic flows can be used for on-chip sample preparation such as mixing of reagents, high pressure generation, and packed-bed chromatography. We have successfully demonstrated the first truly microscale high pressure liquid chromatography (HPLC) system in a chip-based system.

Advanced Materials

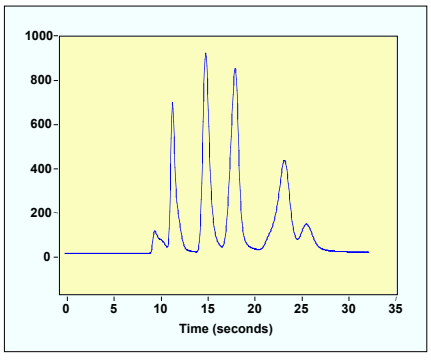
Chemical separations and the control of microfluids in chip-based systems depend on the interactions of the analyte species with a variety of component materials.

At Sandia, and in conjunction with our collaborators, we have developed novel materials engineered to fulfill the needs of micro-separations based systems.

Polymer materials with controlled porosity and high surface area are critical in separations and fluid control, as are materials with tailored surface chemistry.

System Integration and Engineering

The integration of the microseparations-based analysis systems into devices that are compact, portable, rugged, up-gradable and tailored for the end user is key to the success of this program.



Rapid analysis of volatile analytes using the gas-phase device.

We are using our expertise in systems engineering to produce prototype devices, which will be evaluated for their ability to meet all product design goals.

Status

Portable, stand-alone devices for the analysis of chemical agents and protein biotoxins have been developed and tested at the research prototype stage. Current research is focused on improving the performance and expanding the capability of these and other such devices.

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