

Lab-on-a-Chip Technology for Portable Medical Diagnostics

RapiD_x — Rapid, Automated, Point-of-Care System

The rapid, automated, point-of-care system (RapiD_x) developed by Sandia National Laboratories is redefining possibilities for rapid, point-of-care analyses of health and disease status.

The Need for RapiD_x

Protein signatures of infection, disease, or exposure to toxic substances circulate in blood and saliva. Detecting these signatures before symptoms appear is key for early intervention, which is typically less expensive and more effective than treatment at later stages.

Built on Sandia's advancements in lab-on-a-chip technologies, RapiD_x is a miniaturized device that requires mere microliters of a sample to measure protein signatures. With RapiD_x, drawing tubes of blood is no longer required. Instead, drops of blood or saliva can be collected and analyzed at the point of care (e.g., in a doctor's or dentist's office), enabling low-cost, rapid diagnoses during an office visit.

RapiD_x can also be used to address bioterrorism threats. If a crowd is exposed to dangerous biotoxins, potentially



Sandia's RapiD_x can analyze drops of blood or saliva in a doctor's office, enabling low-cost, rapid diagnoses during an office visit.

exposed persons can be rapidly triaged with RapiD_x for timely treatment—critical in such an event—while conserving valuable health resources (e.g., hospital beds, prophylactic supplies).

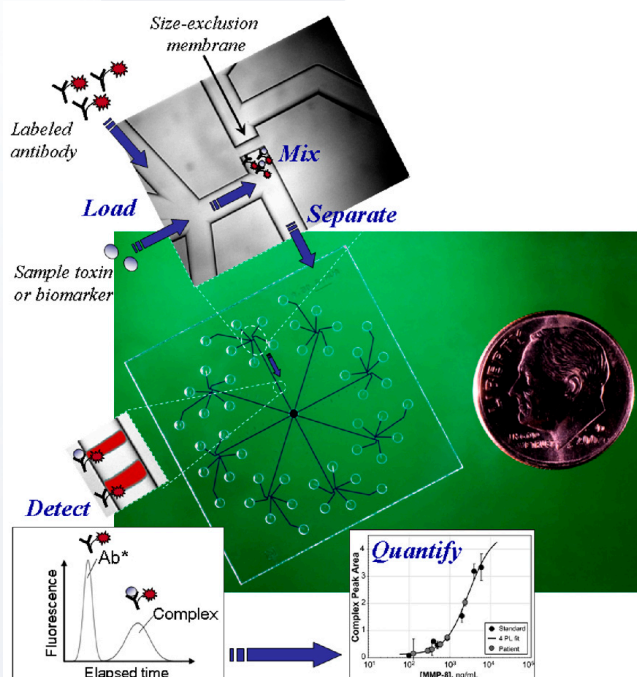
Key Advantages

RapiD_x processes and detects protein signatures by conducting each sample-processing and -analysis step within a microfluidic chip. Our integrated approach is based on highly specific, electrokinetic immunoassays and offers the following key advantages:

- Fast analysis of fluid samples (5–10 minutes), with rapid mixing and separations on-chip, making clinical or field measurements realistic.
- Sensitive quantitation of protein signatures by trapping them at nanoporous size-exclusion membranes.
- Fully automated analysis—including sample-preparation steps and diagnostic tests—through lab-on-a-chip technology.
- Analysis of multiple disease/exposure indicators simultaneously with a single multiplex chip.

A Vision Realized

In the past, researchers envisioned miniaturized diagnostic technologies that could accurately ascertain disease state by using



A variety of diseases, infections, and intoxications can be diagnosed with RapiD_x by switching antibody probes.

droplets of human body fluid. RapiD_x realizes this vision as a lab-on-a-chip instrument that can perform multiple operations in parallel outside the laboratory, such as in field deployment, near-patient environments, and resource-poor settings. In addition, RapiD_x offers the following operating specifications, which are optimal for point-of-care instrumentation:

- **Microfluidic.** Only microliter volumes (e.g., a small droplet of saliva or blood) are required for analysis.
- **Easy sample collection.** Designed for use with saliva or a pinprick of blood.
- **Multiplex.** A panel of up to 64 analytes can be analyzed simultaneously for accurate assessment.
- **Rapid.** A full panel of analytes is measured within 10 minutes, allowing time for results during a routine clinical visit.
- **Sensitive.** Low-abundance markers and trace amounts of deadly toxins can be detected by sample preconcentration.
- **Wide, dynamic range.** RapiD_x is adjustable over several orders of magnitude by timing each preconcentration step.
- **Portable and easy to use.** RapiD_x offers automated, point-of-care testing with a simple touch-screen interface.
- **Low cost.** RapiD_x makes widespread screening, diagnosis, and monitoring feasible.
- **Versatile.** A variety of diseases, infections, and intoxications can be diagnosed by switching antibody probes.



A project funded by the National Institute of Allergy and Infectious Diseases is studying the use of RapiD_x to rapidly screen individuals for biotoxin exposure.

monitoring of disease or intoxication. Our device directly impacts a number of critical areas of national concern.

- **Disease detection.** A Sandia project funded by the National Institute of Dental and Craniofacial Research used the RapiD_x microfluidic platform to analyze clinical samples and detect a collagenase enzyme associated with periodontal disease. Unlike the traditional approach—which uses invasive techniques—RapiD_x has the potential to diagnose patients with periodontal disease at the first signs of microscopic bone loss, enabling treatment before significant damage occurs. The highly versatile RapiD_x can also be used to detect biomarkers that may be presymptomatic indicators of disease, such as cancer or cardiovascular disease.

- **Ultrasensitive research tools.**

The microsystems developed for RapiD_x are a step towards fulfilling fundamental needs for highly specific, ultrasensitive, high-throughput, low-cost analytical tools that will not only improve our understanding of host response to infection and illness, but also aid researchers engaged in drug discovery, biomarker verification, and new strategies for therapy.

- **National defense.** Troop readiness and field medical diagnosis and treatment are top priorities in national defense. RapiD_x allows rapid, simple, and comprehensive diagnostics at low cost at a clinic or in the field. The device also enables quick and effective triaging in the event of intentional crowd exposure to biotoxins, thus improving the outcome for victims and enabling better use of healthcare resources. A Toxin Diagnostics Project, currently funded by the National Institute of Allergy and Infectious Diseases, is using RapiD_x to rapidly screen individuals for exposure to a number of biotoxins. RapiD_x provides direct detection of toxins, as well as the signature proteins that are elicited in response to toxin exposure.

Versatile Applications of RapiD_x

Sandia's RapiD_x project has demonstrated the potential for portable diagnostics to impact healthcare and homeland security by facilitating early detection, intervention, and

For More Information

Business Contact: Laura E. Santos, (925) 294-1214, lesanto@sandia.gov
 Technical Contacts: Anup K. Singh, (925) 294-1260, aksingh@sandia.gov
 Anson V. Hatch, (925) 294-6291, ahatch@sandia.gov
 Website: roswell.ca.sandia.gov/hatch.html



Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

SAND 2008-6574
 October 2008

AY10401



**Sandia
 National
 Laboratories**