Chemical and Biological Detection & Defense

RAMiTS (RAMan Integrated Tunable Sensor)

Army Issues and Technology Impact

Rapid evaluation of potentially hazardous materials such as explosives, chemical warfare agents, and bio-substances (e.g., powders, spores) is becoming increasingly important for weapons inspection, covert reconnaissance missions, and domestic security. The ability to detect weaponized chemical and biological warfare (CBW) agents before they can affect large numbers of people is vital to mitigating their effect. Current methods of analysis require many different types of instrumentation, depending upon the analysis, and in many cases require actually sampling the material of interest.

A battery-operated, field-portable Raman instrument, RAMiTS, can perform automated analysis of hazardous chemicals in the field. RAMiTS can analyze a sample in seconds and instantly notify the user of the sample's identity. In addition, a sample can be identified through a transparent container simply by pointing a fiber optic probe at the sample.

Technical Concept

ORNL's Advanced Biomedical Science and Technology Group has developed a lightweight, portable sensor for the identification of chemical-biological species, including explosives, toxic chemicals, and drugs. This instrument is based upon high-sensitivity Raman spectroscopy, an optical technique that can measure the vibrational signature of most chemicals, both solids and liquids. To obtain this chemical signature, laser light is focused onto the sample, and the resulting scattered light is collected and detected. Using this instrument for chemical and biological sample identification has several advantages over conventional analysis, including these:

- The user need not contact the sample.
- Analysis is rapid, in most cases 11 seconds or less.
- An embedded computer system performs rapid automated sample identification.
- User interaction with the system is via a touch screen.
- RAMiTS operates on battery power, with a single-charge lifetime of 3 hours.
- The instrument is watertight and can be decontaminated after exposure to CBW agents.

The RAMiTS instrument

The RAMiTS instrument is much more rugged than conventional analysis tools because it is based totally on solid-state technology and no moving parts. Initial testing of the instrument and its automated identification of chemical warfare agent simulants and explosive simulants has been performed for both pure compounds and mixtures. In these analyses, the instrument proved to be capable of identifying the various chemicals present in either a pure form or a mixture. Because of its high spectral resolution, RAMiTS can differentiate among structurally similar compounds and isomers of the same compound. Using this instrument in conjunction with sample vials developed at ORNL, it is possible to detect even trace amounts of chemical species with minimal sample handling.

Development Approach

Three prototype instruments are currently being developed for the FBI's hazardous materials unit, and final evaluation of the instrument based on the FBI's needs will occur within the next 6 months to a year. To further refine a device specifically for the Department of Defense (DoD), several tasks would be performed:

1. Collaborate with Edgewood Arsenal to evaluate the ability of RAMiTS to detect CBW and explosive agents of interest to the military.
2. Investigate and implement a wireless link within RAMiTS to upload data to a central location. Such a capability would allow remote deployment of the instrument using robotic delivery systems.
3. Develop and evaluate an add-on component that can make measurements up to several hundred feet away from the instrument. Such long-distance analyses could prove useful in difficult-to-reach locations.

ORNL Facilities

ORNL's Advanced Biomedical Science and Technology Group is a multidisciplinary team of physicists, engineers, chemists, and biologists with experience in optics, electrical circuit design, instrument development, and detection of explosive and CBW agents. ORNL has several proprietary technologies related to the RAMiTS device.

Related Programs

The proposal to develop a portable RAMiTS system for the Army would benefit from ORNL's experience in developing an existing prototype device designed and built for the FBI's hazardous materials response unit. ORNL could leverage previous expenditures of more than $900,000 on the RAMiTS technology and provide a functional system upon which to build.

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