SERDP Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

The Sensitive Detection of Unexploded Ordinance and Other Hazardous Materials

Cleanup
CU-713

LEAD AGENCY: Army

LAB: Army Research Laboratory, Aberdeen Proving Ground, MD

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PROBLEM STATEMENT: The development of laser-based, analytical sensors for the rapid detection and monitoring of trace atmospheric vapors in real-time has been of great interest in recent years. Environmental issues pertaining to pollution prevention, compliance, and cleanup have been an important driving force behind this development. Another related issue deals with the detection of trace atmospheric vapors of energetic materials such as explosives and propellants. This is not to surprising given the potential civilian and military applications for these developing technologies in aviation security, demilitarization, and cleanup activities. The overall objective of this proposal is to develop and deploy a reliable and cost-effective apparatus for the sensitive detection of energetic materials as well as toxic halogenated compounds and heavy metals as identified by the Major Range and Test Facility Bases (MRTFB) Environmental Coordinating Committee.

PROJECT DESCRIPTION: At the 1992 Army Science Conference, we presented a paper which received first prize and was awarded the Paul A. Siple Memorial Award. In this paper, we described a novel technique for sensing trace atmospheric vapors of energetic materials and chemical agent simulants. This technique (patent pending) is based on the use of one laser operating to both photofragment, the target molecule and detect the characteristic fragments by resonance-enhanced multiphoton ionization (REMPI) and/or laser-induced fluorescence (LIF). The analytical utility was demonstrated on a number of compounds, including TNT and RDX, employing molecular beam mass spectrometry. A detection limit of 8 and 24 parts-per-billion (ppb) was obtained for RDX and TNT, respectively, using only 100 µJ/pulse of laser energy.

A literature review of the electronic transitions of NO reveals that they are also resonant with 193 nm or 222 nm radiation, the output from an excimer laser. The advantages of using this laser over that used previously is that it is more rugged, more compact, and readily fieldable. In addition, the output is approximately a few thousand times more than the 226 nm radiation used for the detection of TNT and RDX. As a result, we expect to improve substantially on our limits of detection of these and other energetic materials. For this proposal we plan the following:

- Replace 226 nm laser system with a compact excimer laser.
- Replace our molecular beam time-of-flight apparatus (approximately 64 ft3) with a hand held optogalvanic detector. In addition to reducing the size of the apparatus, a ten to one hundred fold increase in sensitivity is projected due to direct atmospheric sampling.
- Add a cryogenic stage for enhanced selectivity and modify sample delivery for enhanced sensitivity.
- Extend this technique for the detection of volatile organic compounds (VOC's).
- Fabricate and deploy prototype.
- Identify source of pollutants for cleanup/remediation actions.

Complementary conventional monitoring techniques such as x-ray fluorescence and atomic absorption will also be used if needed.

This project is presently being supported by an Army Research Lab Independent Laboratory Innovative Research Award and leveraged by Small Business Innovative Research funds.

Benefits:

- A rapid and ultra-sensitive, real-time, laser-based detector which will have both military and civilian applications. Excellent potential for opening up new commercial and military markets.
- Reduction of costs of cleanup/remediation for sites containing energetic materials, heavy metals, and halogen-containing compounds.
- Increased safety to personnel working at site or involved with cleanup activities.

TRANSITION PLAN: Technology transfer would take place via the Army Safety, Health, and Environmental Directorate. Cooperative Research and Development Agreements with Navy, DOE, EPA, FAA, and various industries would be established. Financial support for transitions would result from ARL and DSHE, leveraged by Stablelase, Inc., Polymicro, Inc., and General Fiber Optics, Inc. via SBIR Phase II Projects. Funds from other agencies requesting sensor technology are also projected.