Field Portable FTS Fiber Optic VOC Sensor

Cleanup
CU-103

LEAD AGENCY: Air Force

LAB: Wright Laboratory

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PROBLEM STATEMENT: The goal of this project is to develop a prototype field portable Fourier Transform Spectrometer (FTS) that will detect and measure the presence of volatile organic compounds (VOCs) in soil at hazardous waste sites and long term compliance monitoring stations. Rapid on site screening of soils for VOCs can be accomplished by analyzing Raman or laser-induced fluorescent signatures. This project builds a new type of FTS that marries a fiber-optic light delivery and collection system with a compact optical design that requires no mechanical scanning. The spectrometer is based on a miniature common-path interferometer and a unique solid-state light sensor that provides light detection and spectral processing on a single integrated circuit. The prototype's monolithic FTS chip will also be tested for dual-use applications in laser warning receivers, IFF, and laser communications configurations.

VOC sorption in soil depends on the availability of bonding sites, and the amount of mineral surfaces, organic matter, and moisture in the soil. This creates problems when trying to determine the actual VOC concentration in a particular sample. Current analysis protocols mitigate this problem by calling for bulk soil collection taken from the hazardous waste sites to be shipped to laboratories. At the laboratory, sub samples are drawn from the bulk sample and analyzed by purge-and-trap gas chromatography/mass spectrometry (EPA SW-846, method 8240). To overcome the soil property variances and rapidly characterize a hazardous waste site, the ideal instrumentation for in situ VOCs determination would allow multiple VOCs of interest to be identified and measured simultaneously in real time. Additionally, such an instrument should be hand-held and should not use water as an extractant or dispersion medium (to avoid displacing the VOCs). Direct spectral measurement of VOC analytes using remote spectroscopy techniques should avoid sample preparation involving water.

PROJECT DESCRIPTION: This project investigates feasibility of producing a ruggedized instrument package that includes a set of fiber optic sensors with coupling to a proprietary FTS configuration comprised of a miniature common path interferometer and proprietary imager/signal processing chip. The objective is to develop an instrument that will have sufficient performance to support VOC detection in a field environment.

The technical approach to this effort will include the use of a proven method of obtaining the spectral signatures of target contaminants including a fiber optically coupled FTS. Spectrochemical analysis will be used to characterize the optical signatures of the contaminants and develop appropriate and effective detection algorithms. The Proof-of-Concept investigation will focus on trichloroethylene (TCE), Benzene (Ben), and Toluene (Tol) because they are frequently encountered due to use in industrial solvents and petroleum products and are on the EPA 17 Target Chemicals Lists.

This program's effort will be a synergistic combination of integrated research spectrochemical analysis, detection and identification algorithms, optical design, and novel detector design and fabrication.

This project directly contributes to the objectives identified in the Tri-Service Environmental R&D Strategic Plan, Pillar 1: CLEANUP: Requirement Thrust; 1C Characterization and Monitoring.

EXPECTED PAYOFF: This device will have dual-use application, with potential government and commercial users. Potential users would have a need to detect, categorize, and measure VOCs and HAZMATS. The impact of this device would be a device capable of mapping VOC concentration contours at hazardous waste sites or EPA soil pollution limit compliance monitoring at DoD and DOE facilities and throughout the industrial base. The FTS chip/interferometer design will be of important and immediate use for priority laser warning receiver research on single aperture laser warning receivers and combined missile warning/laser warning receivers.

TRANSITION PLAN: WL/AAWP-3 LWR EO Laboratory will be the Government agency managing the program. The development contractor and Cooperative Research and Development Agreement (CRADA) partner will be Remote Spectral Capture. Validation testing in the interested instrument-manufacturing firms will lead to cooperative opportunities for technology transfer to the commercial market. Potential users will be involved in all aspects of the test execution and post test analysis.