LOCALIZING CHEMICAL AND BIOLOGICAL THREAT DETECTION

In-field Vapor Threat Identification Using FT-IR Spectroscopy In Mounted And Dismounted Modalities

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The infrared (IR) absorption spectrum is a physical constant of a molecule and a highly specific signature arising from vibrations within the molecular structure framework. The inherent specificity of IR spectroscopy allows the identification of a large number of vapor phase compounds with high probability of identification. Fourier transform infrared (FT-IR) spectroscopy is a well-known, mainstay analytical method for the identification of unknown materials in any physical state - gas, solid, or liquid - across many disciplines. For operators in the field, toxic vapors represent one of the most serious threats. Threats can be from several classes of materials or release scenarios, including chemical warfare agents (CWA) or toxic industrial chemicals (TICS) on the battlefield or the accidental release of industrial chemicals. Several instrumental methods are used to analyze vapors in the field. These technologies can suffer from a lack of specificity, limitations on the number of gases that can be detected, high cost, or a lack of portability. A gap exists for a highly portable, cost-effective vapor identifier used for in-field identifications of potential vapor phase threats to personnel and operations. We have developed new FT-IR spectrometer platforms specifically for use by operators in the field. We will present an overview of the design and technology employed in these new, miniaturized FT-IR spectrometer platforms and present some recent results of laboratory and field testing.

Two versions of this instrument were developed – a handheld for dismounted operation and a version suitable for mounting on mobile platforms using wireless, remote operation. For both instruments, the spectrometer platform employs a double pendulum interferometer operating at 4 cm-1 spectral resolution and requiring no alignment. The rotary interferometer with associated cube-corner retroreflectors is self-correcting for tilt and shear that may be introduced through shock or vibration while in use. A small pump draws ambient vapor into a 2 meter optical pathlength, 37 ml volume gas cell. The XplorIR™ handheld instrument, for dismounted operation, weighs ~5 lbs and operates on batteries for up to 6 hours. The InterceptIR™ is an FT-IR instrument that is hardened for mounted operations on unmanned ground (UGV) or airborne (UAV) vehicles. Both instruments can be operated in in a continuous monitoring mode. An unsupervised, adaptive algorithm allows near real-time identification of components in mixtures. The on-board spectral library contains more than 5,600 vapor phase spectra including signatures of CWA, TICS, precursor dual use chemicals, fuels and accelerants, pesticides, and common laboratory chemicals. In laboratory testing for numerous TICS, the probability of detection exceeds 0.95 when above the limit of detection (identification). The limits of identification of pure components or materials in mixtures are 10-100 parts per million depending on the molar absorptivity of the material.

Results from laboratory testing will be presented including controlled, quantitative experiments with CWA, TICS, and interferents. We will also present results from recent field tests in dismounted and mounted operations.