Application Note: 101

Explosives Identification: Raman and FTIR Applications

Key Words

- First Responder Safety
- Explosives Identification
- Raman Spectroscopy
- FTIR Spectroscopy
- Homemade Explosives

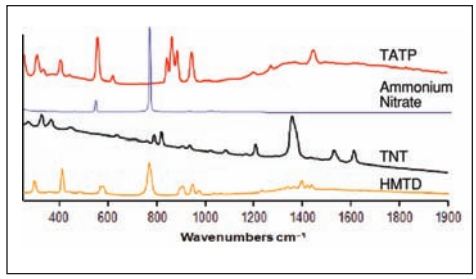
Rapid, precise identification of explosives is one of the key tasks for homeland security and public safety personnel, especially with the marked increase of improvised explosive device (IED) usage worldwide. Portable X-ray devices and trained canines assist first responders in determining the presence and location of explosives, but are not effective in the identification of unknown explosive materials. Instruments that can be used in the field to rapidly and accurately identify various explosives—and their precursors—are essential tools for bomb technicians responsible for the safety and security of the community.

Thermo Scientific handheld chemical identification instruments provide precise, actionable intelligence which increases both responder and community safety. The underlying technologies in the FirstDefender® and TruDefender® analyzer product lines offer distinct advantages in specific explosive applications, and when used together, provide complementary and confirmatory results. Bomb technicians worldwide rely on Thermo Scientific instruments for rapid, specific identification results to help ensure a safe remediation.

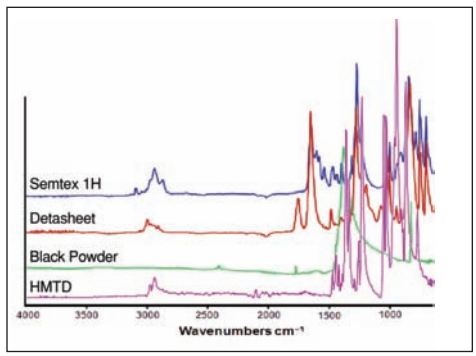
Raman for Explosives

Raman spectroscopy, the technology in the FirstDefender analyzer product line, enables users to safely analyze explosive materials through sealed translucent containers without disturbing the sample. This capability is particularly important for bomb technicians who want to avoid contact with a sample whenever possible.

The FirstDefender analyzer product line is able to recognize thousands of potential explosives including: TATP (triacatone triperoxide), ammonium nitrate, TNT (trinitrotoluene), RDX (cyclonite) and HMTD (hexamethylene triperoxidediamine). Additionally, the instrument is capable of identifying explosive precursors in liquid mixtures including: hydrogen peroxide, fuel oil, acetone, sulfuric acid and more. The device collects the molecular fingerprint of an unknown sample, and then compares the substance against the onboard chemical library, typically providing results in a matter of seconds. Raman instruments excel at identifying liquids, gels, pastes and light colored solid materials. Raman technology utilizes a 785nm laser, which can heat some energetic materials, so proper safety protocols should be followed to ensure operator safety.



Unique Raman spectra of TATP, TNT, ammonium nitrate, and HMTD.

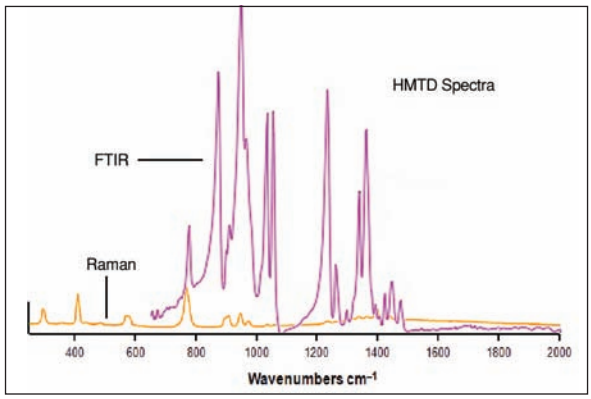


Unique FTIR spectra of Semtax 1H, Detasheet, black powder and HMTD.

FTIR for Explosives

Certain explosive materials and their precursors have the potential to display fluorescence (generation of light during Raman sampling) which can limit identification by a Raman instrument. FTIR is ideal for potentially fluorescent samples because of the way FTIR spectroscopy interacts with an unknown sample—the TruDefender FT device will not cause a material to exhibit this phenomenon.

FTIR spectrometers are also exceptionally useful for identifying unknown chemicals of a variety of colors. They will not generate energy during the sampling process, which makes it an ideal tool for verifying substances such as: Red Dot, smokeless powders, Pink or Green Detasheet, Semtex, or hundreds of other colored materials. Since contact is required between the sample and the instrument, caution should be taken when analyzing pressure sensitive substances.



Using Raman and FTIR technology together can provide confirmatory results.

Thermo SCIENTIFIC

Next Generation Raman Spectroscopy

The Thermo Scientific FirstDefender RM and FirstDefender RMX instruments, our next generation Raman spectrometers, enable rapid, accurate identification of unknown chemicals directly in the field. Building on the award-winning, field proven FirstDefender instrument (now sold as Thermo Scientific AhuraFD), significant improvements have been made in speed, performance, mixture analysis and user interface incorporating extensive user feedback.

The FirstDefender RM unit is less than half the size and weight of the first generation instrument, with a large, vivid display for ease of use in bulky protective gear. It is designed to meet the demanding requirements of elite military personnel and civilian first responders. The FirstDefender RMX instrument expands these capabilities with a fixed probe attachment, allowing users to easily scan in hard-to-reach areas. The FirstDefender RMX unit can also be mounted on select tactical robots using the RS232 port and an integration kit provided by the manufacturer.

The FirstDefender RM unit can analyze through sealed containers without disturbing the sample.

Bomb squads, hazmat teams and other first responders rely on Thermo Scientific chemical identification instruments.

Field-Based FTIR

The Thermo Scientific TruDefender FT and TruDefender FTi instruments are rugged, handheld FTIR systems for rapid, in-the-field identification of unknown chemicals including explosives, narcotics, toxic industrial chemicals, precursors and more. The TruDefender FTi instrument adds to this core functionality by providing a direct link to incident command or reachback support through embedded mobile phone technology. Built for first responders, the TruDefender analyzers weigh less than 3.5 pounds (1.59kg) and are rugged enough to withstand the rigors of field use.

When used together, the TruDefender and FirstDefender product lines provide confirmatory results and a broader range of unknown substance identification.

In addition to U.S. offices, Thermo Fisher Scientific maintains a network of representative organizations throughout the world.

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