PENDAR TECHNOLOGIES

Pendar X10

for Explosive Ordnance Disposal Applications

OVERVIEW

Explosive Ordnance Disposal (EOD) technicians work quickly and quietly behind the scenes to eliminate threats. These threats include homemade explosives (HMEs), expired pyrotechnics, and unused ammunition. Threats must be differentiated from benign substances such as protein powders, beverages, or harmless household materials. Identifying the substances discovered on scene is key for any successful mission.

First responders, especially EOD technicians, now rely on portable spectroscopy for chemical identification. Knowing the chemical identity of a hazard dramatically improves any operation. Unfortunately, standard Raman and Fourier-transform infrared (FT-IR) spectroscopy devices add complexity and slow down response. The risk of igniting unknown bulk materials with high power lasers endangers first responders.

Pendar X10 introduces a range of game-changing technologies that transform how military and public safety personnel, including EOD technicians, CBRN specialists, and Special Forces make life-saving decisions. In this application note, we will explore the advantages Pendar X10 offers first responders and our Joint Forces.

TECHNOLOGY

Pendar X10 provides remarkable advantages in terms of safety, speed, and ease of use. Combining Difference Raman spectroscopy with stand-off measurement and advanced optical design, Pendar X10 brings more power and performance to portable spectroscopy than ever before.

Pendar X10 can safely identify explosives on site without the need of sampling, unlike traditional handheld Raman or FT-IR tools.

Safety

Instead of focusing the Raman laser's energy on one small area of the sample and risking ignition, Pendar X10's internal optical actuators rapidly move the beam over the substance. The automated fail-safe system monitors the laser beam motion and ensures that any anomaly instantly triggers a shut-off. Pendar X10 provides two distinct safety advantages:

1. Pendar X10 eliminates the risk of overheating samples of sensitive primary explosives and gunpowder, preventing dangerous ignition.

2. Pendar X10 minimizes eye injury risks and delivers Class 3R for eye safety, outperforming the industry standard Class 3B, which requires the use of special laser safety goggles.

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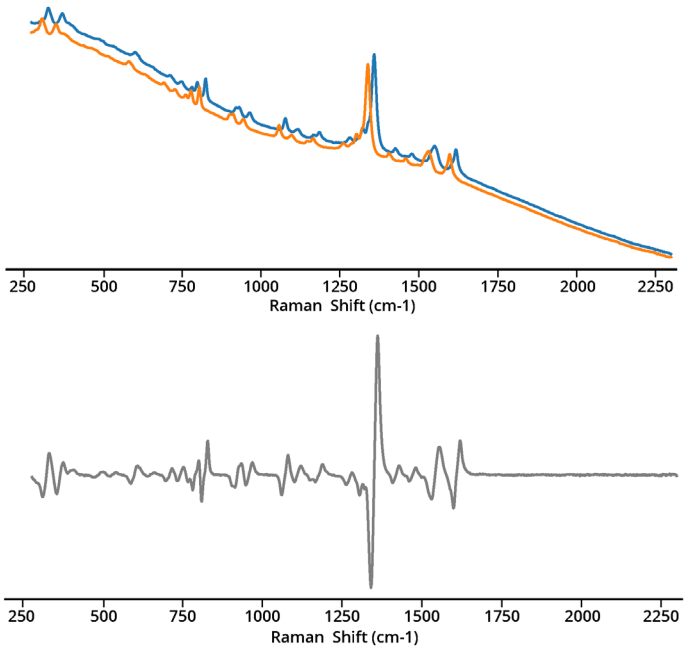
Safely scanning through glass or plastic barriers like a glove box or oven is made possible by Pendar X10's stand-off measurement capability.

Stand-off Measurements

Other handheld Raman systems are limited to short measurement distances, often requiring direct contact with the sample to prevent ambient light interference or to increase signal strength. Additionally, measurements of substances that might be located under fume hoods, behind windows, in thick plastic bags, or in containers with small openings, necessitate sampling of the material. This can disturb the scene, damage evidence-gathering efforts, or slow down an operator resulting in mission delay. Standard systems expose operators to toxic substances and cause instrument contamination. Pendar X10 eliminates these limitations. It is a practical standoff Raman system that can scan through a variety of containers or barriers at distances up to 6 feet.

Pendar X10 being used to safely and quickly identify home-made explosives.



Difference Raman measurement of tetryl. Pendar X10 has two lasers which acquire two slightly different Raman spectra. These are subtracted to eliminate fluorescence.

Difference Fluorescence

Pendar X10's Difference Raman technology was designed to eliminate issues with fluorescence. Two Raman laser beams with closely spaced wavelengths successively acquire two Raman spectra. The fluorescent and ambient light spectra are unaffected by the change in wavelength between the two measurements, but the Raman spectrum is shifted by an amount equal to the frequency difference between the two Raman lasers. The information-rich Raman component can be extracted from the other signals to identify dyed, mixed, or degraded chemicals. An example is shown in the above spectra of tetryl.

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APPLICATION

Pendar X10's technological advancements translate to real-world applications:

Part 1: Safety

Traditional portable Raman spectroscopy eliminates the ability to scan primary explosives or sensitive materials, especially in bulk or on dark surfaces, since high laser power can easily cause detonation. Pendar X10's low-power, rapidly moving laser allows the safe scanning of black powder and sensitive primary explosives like mercury fulminate.

Part 2: Stand-off Measurements

When planning a mission for disposal or arriving on a scene for sensitive site exploitation, reducing any manipulation of unknown chemicals improves operator safety and evidence preservation. Pendar X10 works within a flexible 30 cm to 200 cm stand-off range that introduces a safe distance between the operator and potential hazards. Pendar X10 can even reach into spaces like fume hoods or glove boxes. In a dangerous HME situation, it is essential to leave unstable primary explosives undisturbed. Materials such as red phosphorous (found on the side of matchboxes) and triacetone triperoxide (TATP) can be scanned without risk of ignition.

Part 3: Fluorescence

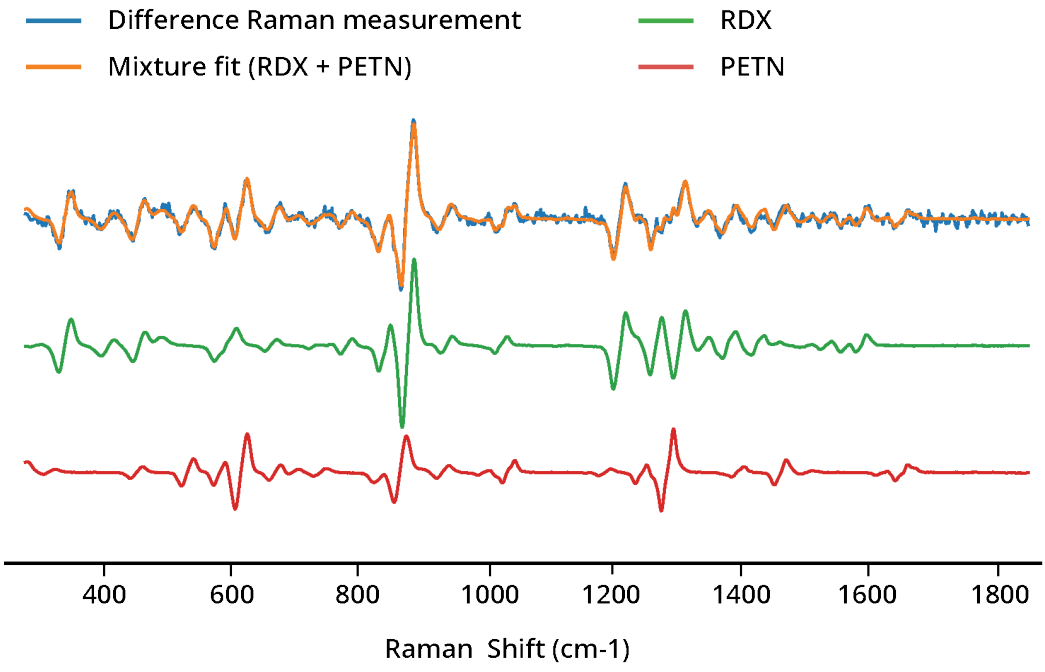
Fluorescent substances are common in the field, including dyed pharmaceuticals or colored household explosives precursors. Fluorescence is a well-documented issue that plagues portable Raman spectroscopy and can cause the misidentification of chemicals. Pendar X10's portable Difference Raman is a proven solution, superior over portable FT-IR spectrometers that require sampling. Raman spectrometers with 1064 nm wavelength lasers reduce performance and have the same detonation risks as 785 nm lasers. See the example on the next page that shows a fluorescent substance prone to misidentification with standard Raman spectroscopy.

Pendar X10 scans an unknown substance remotely in a suspicious backpack left behind on a subway.

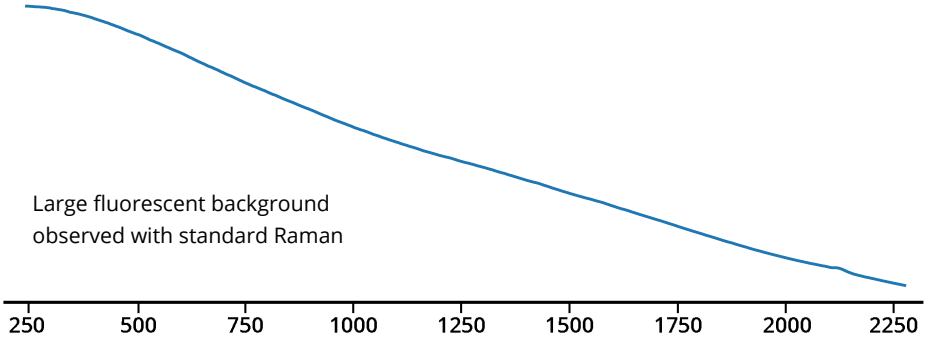
Examples of explosives and precursors that Pendar X10 can safely scan:

- Nitroglycerin
- Acetone peroxide
- TNT
- Cellulose nitrate
- RDX
- PETN
- HMX
- Deta Sheet
- Mercury fulminate
- Semtex 10
- Black powder
- Flash powder
- Potassium chlorate
- Red phosphorus

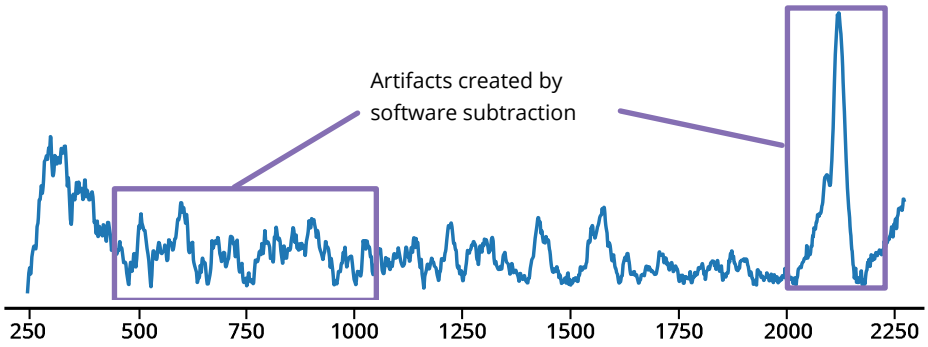
Difference Raman has inherent fluorescence rejection and can easily extract Raman information from difficult samples. In the example below Difference Raman easily identifies the two main components of Semtex (RDX and PETN), a highly fluorescent sample.



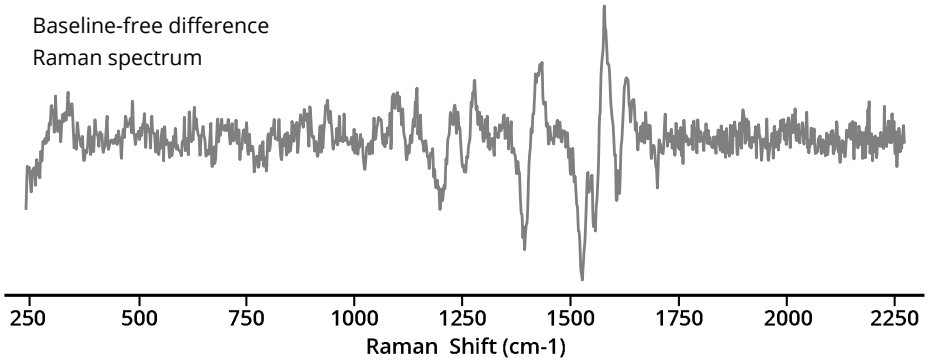
Standard Raman spectrum of an organic HME fuel.



Baseline subtraction can produce artifacts and peaks that can cause false positives.



Difference Raman removes interference from fluorescence and only reveals important peaks for identification, with no artifacts.



Pendar X10 identifies unknown substances in a clandestine lab.

SUMMARY

Pendar Technologies' core mission to use cutting-edge technology to support first responders has led to breakthrough research resulting in a redefinition of chemical identification. Pendar X10 increases the number of identifiable chemicals, improves eye safety, and reduces ignition hazards. Pendar X10 simultaneously increases operational speed and accuracy while offering enhanced safety in dangerous environments.

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