

Rapid-response Forensic Analyses Using Raman IdentiCheck



Raman spectroscopy is playing an increasingly significant role in material identification and characterization. Its ease of sampling and the high specificity of the data produced make it an ideal tool for the rapid and unambiguous identification of many forensically-important materials. These materials range from illicit drugs, explosives and their precursors through to fabrics, polymers and general chemicals.

The advantages of Raman spectroscopy

Raman spectroscopy has some major advantages in the detection and identification of forensically-important materials.

The specificity and fingerprinting-nature of the spectra give easy and definitive identification of the materials in question; no two different materials give the same Raman spectrum and, conversely, if two samples give the same spectrum then the conclusion must be that they are the same material.

The use of a handheld, triggered, remote sampling probe (see Figure 1) makes it easy to analyze a wide range of sample types either at the scene of the incident or in a laboratory.

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The portable nature of some Raman analyzers means that analyses can be made wherever they are required. Raman spectra can be obtained from samples while they are still in their containers, whether glass or plastic bottles, plastic bags, blister packs and even some envelopes. This not only preserves the integrity of the sample but also safeguards the analyst from potential hazard.

The analysis is non-destructive and the sample is available for other types of corroborative testing.



Figure 1. A triggered probe makes it easy to analyze a wide range of sample types at the scene or in a laboratory.

Portability and data quality

The high specificity of the technique relies on having as large a spectral range as possible with as high a spectral resolution (resolving power) as possible. Instruments that generate a full-range spectrum at high resolution will be better at differentiating between chemically similar materials.

To obtain high quality spectra directly through a range of packaging materials requires an instrument with high sensitivity. The greater the sensitivity, the greater will be the chance of a quick, definitive answer.

Some materials have a tendency to fluoresce when subjected to Raman analysis. Where this fluorescence is strong it can mask the Raman signal and render the analysis invalid.

As with most analytical techniques, there tends to be a compromise in Raman spectroscopy between analytical performance and portability. Small, hand-held analyzers have considerably lower performance than their laboratory-based counterparts. For some types of non-demanding analyses this is not a significant limitation. For forensics

or homeland security however, where the materials in question might be chemically similar, it is vital that the investigator has the most reliable data on which to base their decisions.

The consequences of generating poor quality data are significant. Fluorescence can render the data unusable; low specificity and poor sensitivity make positive identification difficult and can increase the probability of getting false positive or false negatives. These are challenges, and particularly so for the non-Raman experts who are often required to do the analysis and make crucial decisions based on the results.

The PerkinElmer® Raman IdentiCheck™ overcomes these challenges by offering the superior data quality associated with a laboratory-based instrument, coupled with the convenience of a hand-held probe combined in a single, portable instrument. Raman spectroscopy is often compared with mid-IR and near-IR techniques. Mid-IR offers the high specificity of Raman but lacks the ease of sampling and the ability to analyze samples through plastic and glass containers. Near-IR lacks specificity but offers the same ease of sampling associated with Raman. A Raman probe system is the only option that gives both of these benefits that are vital for forensic analyses.

The Raman IdentiCheck comes in its own rugged travel case and is controlled via a laptop or tablet PC. The system can be powered by mains electricity, in-car 12V power socket or optional portable power pack.

The flexible, metal-clad, fiber cable and hand-held triggered probe are designed for ease of sampling and the specially designed probe nosepiece (Figure 2) places the sample at the optimum focal distance when the probe is pressed against it.

This nosepiece also ensures that interfering fluorescent lighting or natural daylight cannot enter the probe and cause spurious peaks in the sample spectrum.



Figure 2. The nosepiece eliminates stray light and keeps the sample at the optimum focus distance from the probe.

The unique echelle optical design has no moving parts and delivers full range spectra at high spectral resolution combined with high sensitivity and stability. High resolution and low noise are essential for unambiguous identification of a wide range of forensic sample types including narcotics, explosives and explosive precursors (see Figures 3-6), through a variety of packaging materials. The high sensitivity of the instrument means that these spectra can be collected in a few seconds compared to the several minutes normally required by many existing hand-held analyzers.

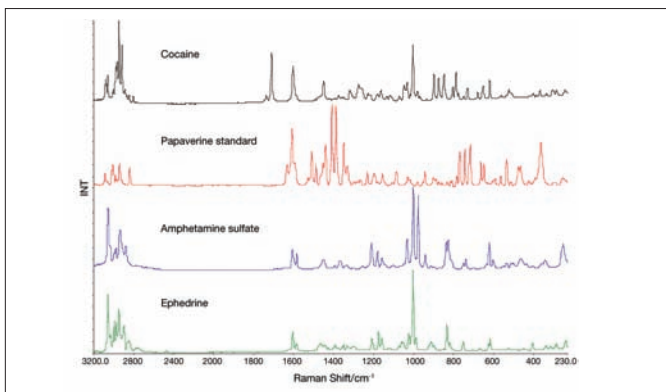


Figure 3. Raman spectra of narcotics.

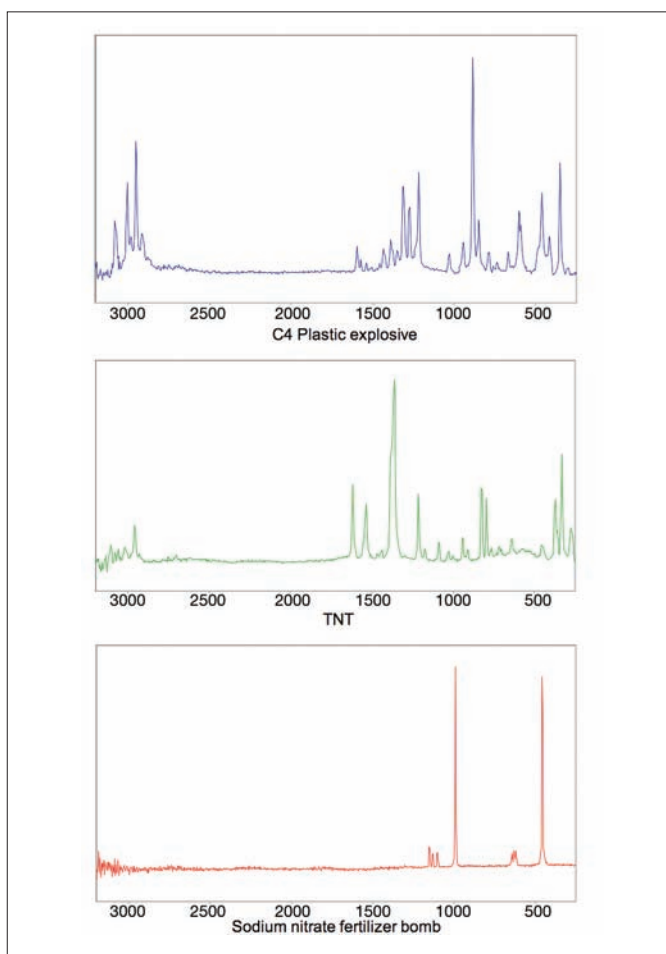


Figure 4. Raman spectra of explosives.

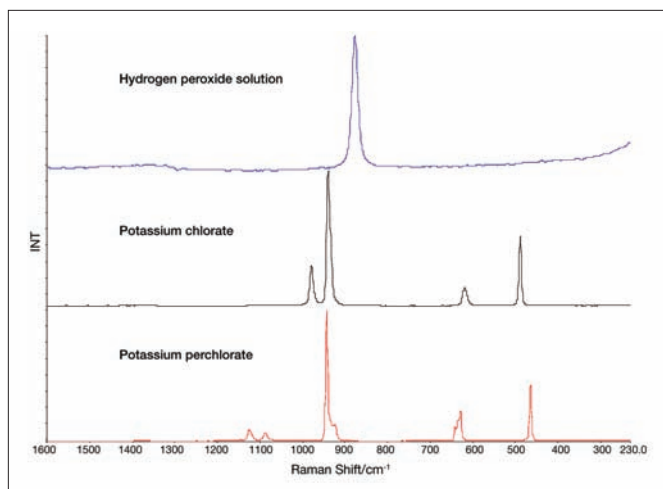


Figure 5. Raman spectra of explosive precursors.



Figure 6. Raman spectra can be obtained through a variety of containers including black plastic bags. The spectrum is of ammonium perchlorate explosive through black plastic bag.

The benefits of using a 785 nm laser combined with photo-bleaching and baseline correction are illustrated in the analysis of a highly fluorescent sample. Figure 7 shows the spectrum of a tablet of the designer recreational drug “Sonic” (methylenedioxypropylvalerone MDPV) before and after photo-bleaching and baseline correction. The processing benefits of photo-bleaching and baseline correction are not normally available on hand-held analyzers but come as standard on the Raman IdentiCheck. These spectra were taken while the tablets were still in their original plastic bag.

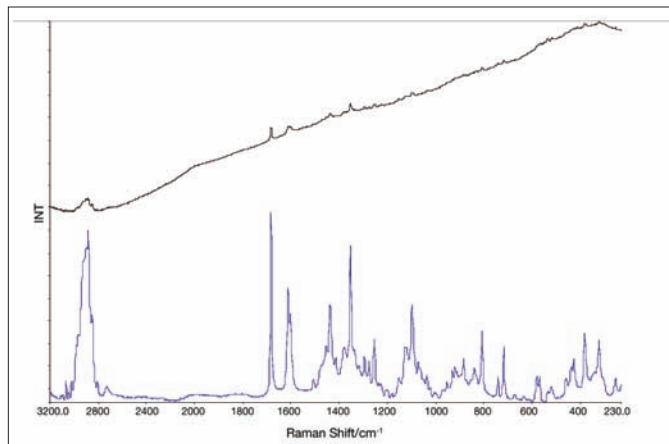


Figure 7. Raman spectrum of a “Sonic” tablet with and without the benefits of photo-bleaching and baseline correction.

The software comes complete with the ability to perform spectral library searching on both user-generated and commercially available libraries (Table 1). The system comes with a narcotics library with additional forensic libraries available.

Automatic wavelength, intensity and laser frequency calibration to recognized standards (ASTM and NIST) give the user full confidence in the fidelity of the data and the results generated.

Table 1. Library Search Result for Sonic Tablet.

Sonic Tablet.sp/Narcotics.dlb		Euclidean Search Hit List
0.999	AB041A	MDPV TABLET
0.568	AB012A	ECSTACY TABLET
0.501	AB018A	LACTOSE
0.454	AB035A	SPLENDIDA SUCRALOSE
0.426	AB019A	LACTOSE PHARMACEUTICAL GRADE
0.371	AB015A	ETHANOL
0.368	AB036A	SUCROSE
0.313	AB037A	DEXTROSE
0.309	AB005A	BENZOCAINE (ETHYL-4-AMINO BENZOATE)
0.234	AB017A	HELIOTROPINE

Conclusions

The Raman IdentiCheck has been developed to give the high-quality data and processing normally associated with laboratory-based instrumentation while providing the convenience and ease-of-use of a hand-held probe analyzer.

It is an ideal analytical tool for the non-specialist to make unambiguous material identification in rapid-response forensic analyses, homeland security, clandestine laboratories and chemical spillage identification.

For further information, visit www.perkinelmer.com/raman

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