# Direct Raman Mapped Imaging of Explosive Materials

**Introduction**

Raman Microscopy has become an established tool in the analysis of surfaces and solid phase particles. The latest automated technology has enabled analysts to study contaminants and surface structure with ease.
Forensic scientists and law enforcement agencies have a particular interest in the verification of the presence of explosives on a surface and to characterise the distribution of individual components within an explosive material.

Previously, destructive methods of analysis such as chromatography and mass spectroscopy and qualitative techniques such as AFM have afforded some information. However, these techniques either require destructive and lengthy extraction procedures or provide little or no direct characterisation of the sample.
In comparison, the Raman microscope can provide non-destructive, *in-situ*, highly specific spectral and distribution information.
We report here a brief study of a surface contaminated with an explosive containing two typical components, RDX and PETN.

**Instrumentation**

The LabRam 1B confocal Raman microscope was used to analyse and interrogate the suspect surface. The LabRam is a compact and rugged single stage Raman spectrometer system that incorporates integral microscope, CCD video camera and holographic notch filter technology. It was configured with the patented Laser line scanning facility and an automated motorised XY scanning stage to enable a full 2-D Raman map to be obtained . An internal HeNe laser and secondary 532 nm laser were also included in the instrument although, for this work only the HeNe laser was used. Due to the unique optical performances in sensitivity and real confocality, the LabRam was able to build up a Raman mapped image of the explosive material with a spatial resolution of around 1 µm.

*Figure 1. The Confocal LabRAM 1B Analytical Raman Microscope System from HORIBA Jobin Yvon.*

Seen here with high and low resolution dual grating option, Integral confocal microscope, CCD video camera, Internal HeNe laser and automated motorised XY mapping stage.

**Experimental**

Digitised white light video images were acquired on the LabRAM system to visually interrogate the sample surface and identify possible explosive contamination.
2-D Raman maps were set up to produce a full analysis of the defined area and obtaining complete Raman spectra from each micron of the surface. The Windows LabSpec software was able to firstly determine spectral characteristics of the different components and then produce a Raman image detailing the localisation of the active explosive components and the binder.

**Results**

- The Digitised white light video image of the sample area to be analysed is shown in *Figure 2*. It can be seen clearly that there is some contamination on the surface. The box indicates the area that was defined for the 2-D Raman map. The size of the mapped area is 20 x 30 µm with a step size interval of 0.5µm.
- Characteristic spectra for each component of the explosive were obtained (*Figure 3*).
- The ν(C-H) stretch Raman bands in the spectral region 2800 - 3200 $cm^{-1}$ were used to produce a Raman image and illustrate the localisation of all of the suspect material, the explosive and binder components. (*Figure 2*).
- The components RDX and PETN were mapped individually and superimposed to illustrate the localisation of the different particles of each explosive component (*Figure 4*).
- The binder was then mapped to confirm the distribution of the inert material. (*Figure 4*)

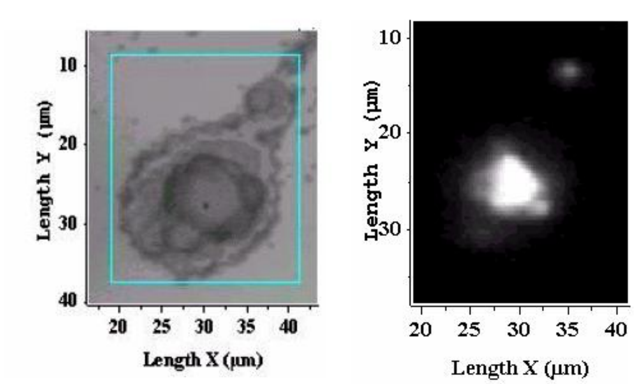


*Figure 2. White light video image (left) of contaminated surface. The box indicates the area defined for the Raman Mapping. Associated Raman mapped image (right) from the* ν*(C-H) stretch Raman bands in the spectral region 2800 - 3200* $cm^{-1}$.

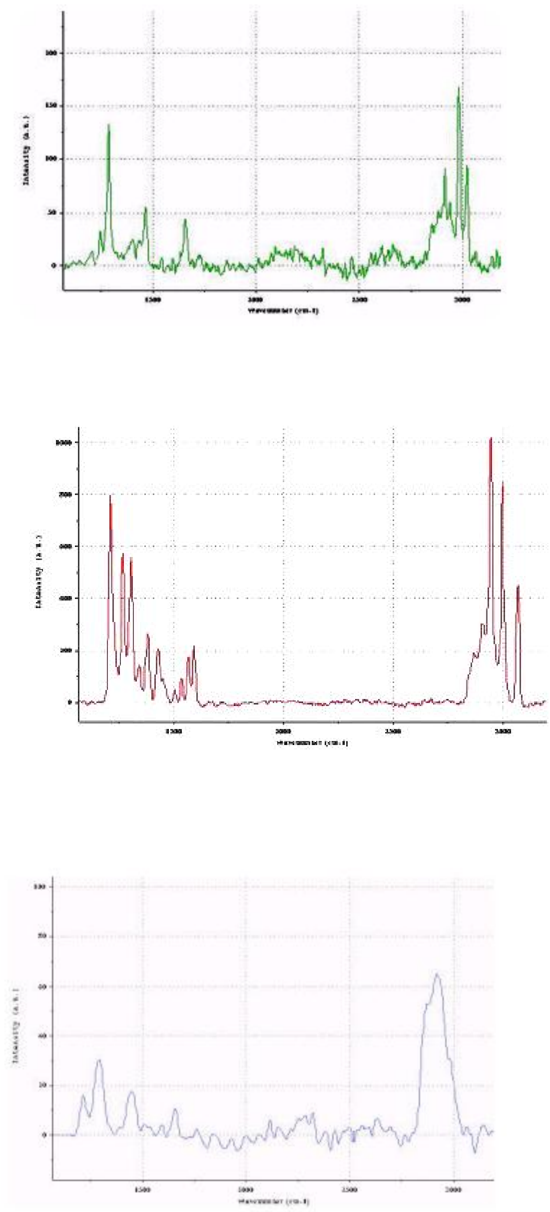

*Figure 3 : Raman spectra for the different components in the explosive material.*

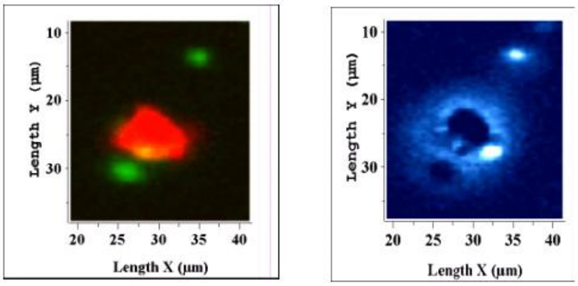


*Figure 4 : Raman mapped image for the two active components red RDX and green PETN (left) and Raman mapped image for the inert binder (right).*

### *Summary*

- From the results obtained by the confocal Raman mapping it is possible to distinguish three main components in the explosive contamination. These have been confirmed as RDX, PETN and binder.

- It can be seen that there is a close positional correlation between the white light image and the images generated by Raman mapping.

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