Application note

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Particle analysis of trace fingerprint residue

Forensics

The role of trace analysis in forensics

Trace analysis is a fundamental area of forensics; it is served using a range of techniques, all with the aim of producing high integrity information which—if necessary—can be used to support the needs of an enquiry. Trace materials can be identified by spectroscopic techniques, usually in conjunction with high quality optical microscopy.

In this example we used a conventional optical microscopy contrast technique to guide targeted chemical analysis using Renishaw's inVia™ Qontor© confocal Raman microscope and Particle Analysis software module. We investigated particulates within a fingerprint on a drink can, revealing detailed information on their chemical composition and particle sizes.

Using image analysis to guide chemical identification

One of the researcher's fingers was lightly pressed against a new, over the counter, pharmaceutical tablet. The finger had no obvious material on it after this contact. The researcher then held a drink can (Figure 1). The region where their finger had contacted the can was then removed to simplify microscopic examination (Figure 2).

Typically, microscopic particulate material is best observed using darkfield illumination, to produce high contrast with the surrounding 'flat' areas. Darkfield illumination with a 5× magnification objective lens did not produce sufficient contrast because of the uneven surface of the can. Instead, oblique illumination from the instrument's own sample enclosure lighting was used, whereby illumination originated from a much shallower angle compared to the light illumination through the 5× objective (Figures 3 and 4). This gave high optical contrast and revealed particulate debris. A series of images (a montage) was collected using oblique illumination over an area of approximately 9.8 mm by 8.2 mm.

Figure 1 – The whole can (with the removed section indicated).

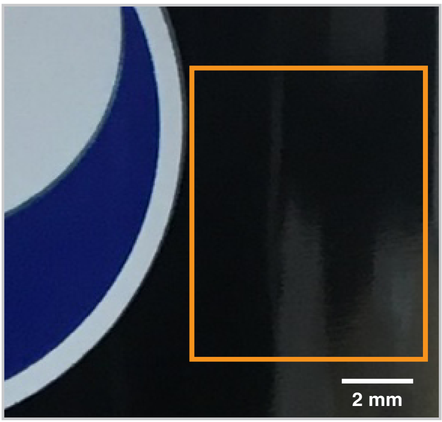


Figure 2 – The removed can section, with the area indicated in which particulate debris was observed.

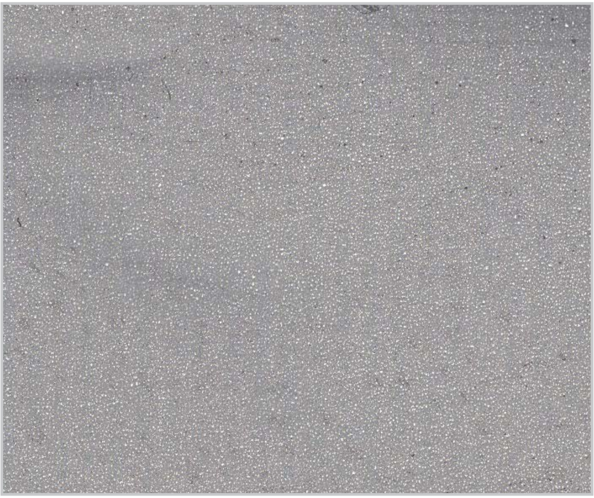


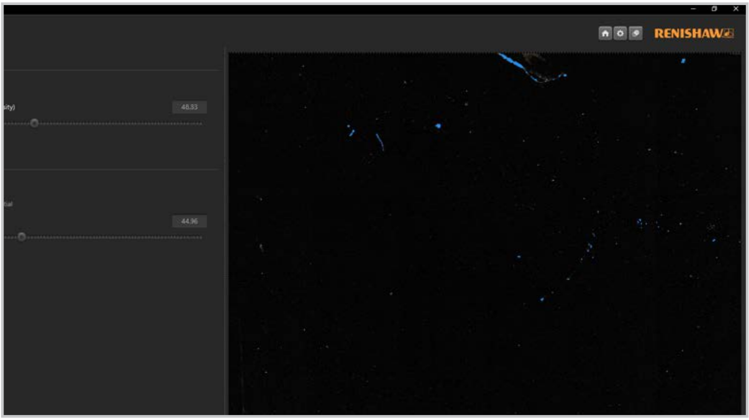
Figure 3 – A bright field image of part of the analysed surface, taken with a 20× objective lens (area 9 mm × 7.5 mm).

Figure 4 – An oblique illumination image of the area in Figure 3, taken with a 5× objective lens (imaged area 9 mm × 7.5 mm), clearly showing some of the particles.

Subsequent Raman analysis was then performed using Renishaw's dedicated Particle Analysis software using the following workflow.

Load image

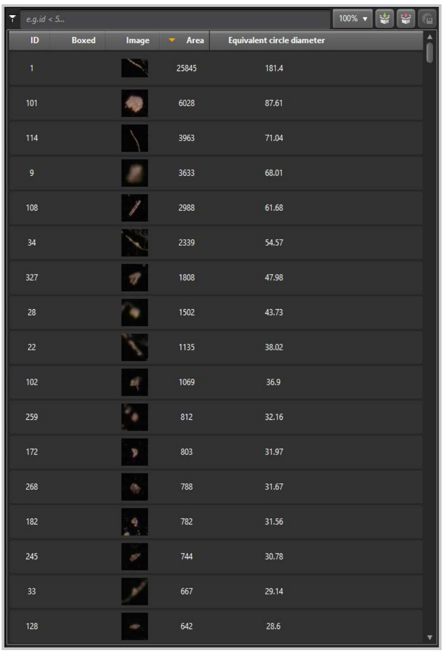
The optical image in Figure 4 was selected for analysis. We set a contrast threshold to highlight the particles and determined the physical metrics of each, as well as their centre positions for subsequent Raman data collection. Any image can be used for this purpose and, while the inVia Raman microscope is configured for high quality optical microscopy and normally more than sufficient for this task, images from other techniques can be used. These can be imported for analysis using the Renishaw Correlate™ software module.



Sort and filter particle list

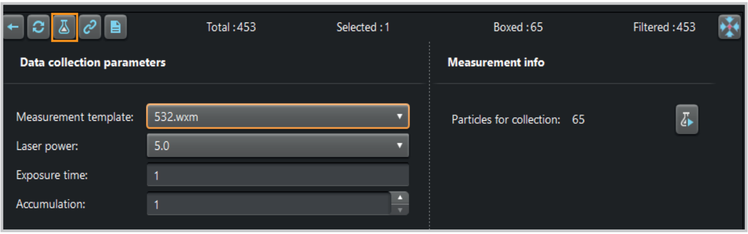
The software generated a list of the particles. This contained an image of each particle, along with all the information specific to it. This list can be sorted and filtered so you can target particles based on size, shape and morphology.

Of the 453 particles which were identified, 65 had an equivalent circle diameter greater than 10 µm and were selected for Raman data collection.



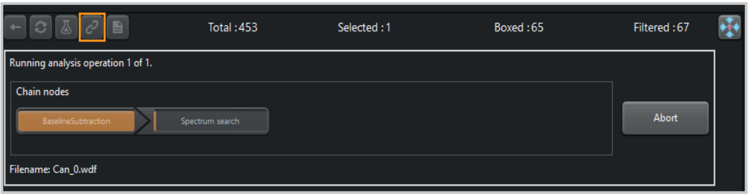
Collect Raman data

Raman data were collected using a measurement template configured for 532 nm laser excitation. Each spectrum was acquired in 1 s, with focus being maintained by the inVia Qontor's LiveTrack™ function. This provided real time height adjustment to ensure the particles were in focus, even over the very uneven surface of the cut can section.



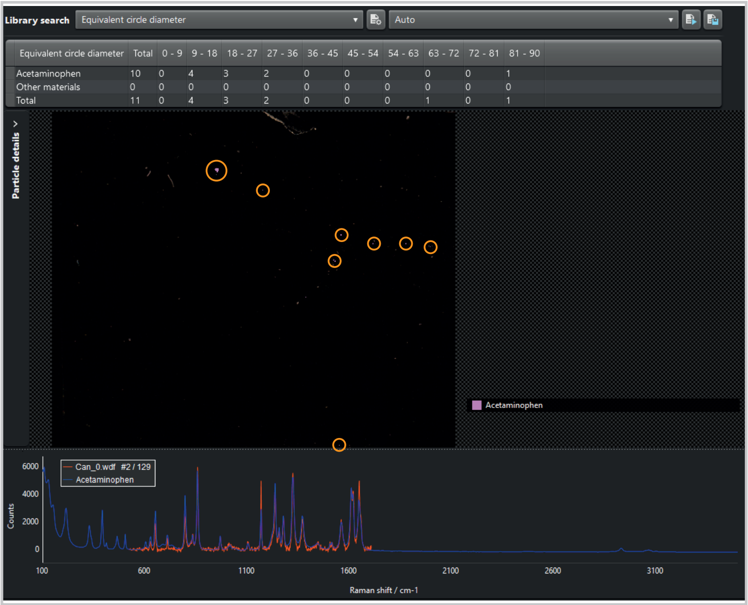
Analyse Raman data

We used the software's Chain option to perform baseline subtraction and library searching in a single automated step. Library search results can be viewed individually, or sorted based on the name of material identified or hit quality index (HQI). The higher the HQI the closer the fit of the spectrum to that of the library spectrum. This approach ensures you report identification results of high confidence.



Report particle identification results

The software consolidates the results into a table, where you can view the identified material and number of particles, relative to a particle size or shape metric. Particles from the original image can also be coloured, based on the material identification. This is a good way of summarising the results visually.



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Identification

10 particles of acetaminophen (paracetamol) were identified from the analysis. These ranged in diameter from 87 µm down to 10 µm (the pre-selected size limit).

These particles are likely to have originated from the finger depositing the print. None of this material is present where the print is absent, supporting this hypothesis.

Unequivocal identification of acetaminophen can be seen in Figure 5, which shows an excellent match between one of the particles and the library spectrum for acetaminophen.

This shows that the inVia Qontor Raman microscope, and the automated workflow of Particle Analysis, can quickly and easily identify trace materials on uneven surfaces, without contacting or modifying them.

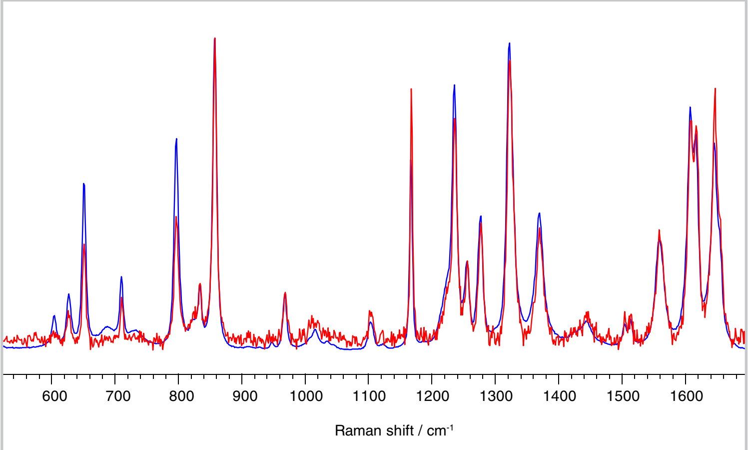

Figure 5 – Raman spectrum from a particle (red) and the library spectrum that identifies it as being from acetaminophen (blue).

Add Raman chemical analysis to your laboratory

The inVia Raman microscope is a powerful chemical analysis tool, ideal for microscopic trace work. Trace materials can be quickly located and targeted for Raman analysis using a variety of optical microscopy techniques (brightfield, darkfield, oblique illumination, polarised). The simple workflow of Particle Analysis, and the high performance and automation of inVia, ensures data are collected quickly and with confidence. Particle Analysis can also use images from other techniques and microscopes to target Raman data collection, making it an ideal complementary tool for trace forensic analysis.

Figure 6 – The inVia Qontor confocal Raman microscope.

A range of related Renishaw literature is available. Please ask your local Renishaw representative for more information.

Renishaw. The Raman innovators

Renishaw manufactures a wide range of high performance optical spectroscopy products, including confocal Raman microscopes with high speed chemical imaging technology, dedicated Raman analysers, interfaces for scanning electron and atomic force microscopes, solid state lasers for spectroscopy and state-of-the-art cooled CCD detectors.

Offering the highest levels of performance, sensitivity and reliability across a diverse range of fields and applications, the instruments are designed to meet your needs, so you can tackle even the most challenging analytical problems with confidence.

A worldwide network of subsidiary companies and distributors provides exceptional service and support for its customers.

Please visit www.renishaw.com/forensics for more information.