application note

Raman identification of chemicals in fingerprints with the Morphologi G3-ID

Introduction

It is common knowledge that fingerprints can be used to identify perpetrators of crimes. Less well known is that particles lodged between the ridges in a fingerprint can provide insight into the *behaviour* of a criminal, if their chemical identity can be determined. The discovery of explosives or controlled substances, for example, can point investigators in very specific directions.

New Approach

The Morphologi G3 is a powerful automated particle imaging instrument widely used for the characterization of dry powders, filtered particles and particles in suspension. To this platform, Malvern Instruments has added the chemical identification capability of a Raman microprobe.

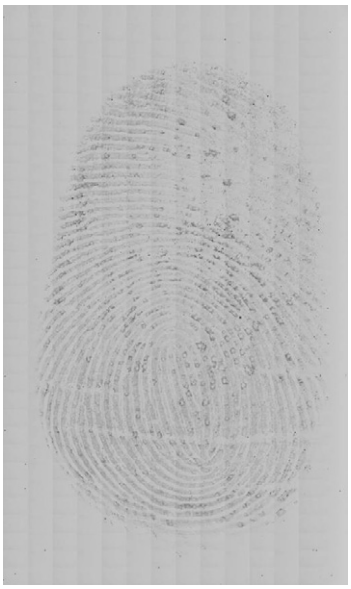

Figure 1: Composite image of the microscopic examination of a fingerprint.

Experimental

The thumb was prepared by wiping it with a tissue, pressing it against a countertop, two different powders, and wiping with a tissue. It was then rolled against an aluminium coated microscope slide, creating a fingerprint with entrapped particles. One of the powder samples and the dust from the countertop were used to mimic normal expected variability in fingerprints

A series of visible images across the region of interest is automatically acquired. The composite image comprising the entire area scanned can be saved as a standard image file (example in Figure 1).

As each image is acquired, particles in the field of view are identified. A thumbnail image of each particle is created and stored along with corresponding size, shape, location and intensity parameters.

The second step is the selection of suspect particles for further chemical characterization. For example, the user may want to ignore all fibers, as determined by length, aspect ratio and transparency.

The third step is the actual acquisition of the Raman spectra (Figure 2), and subsequent chemical identification.

Results

The fingerprint shown in Figure 1 was imaged at a magnification of 5X. 37,447 particles were imaged, measured and saved in seven minutes. Only particles larger than 4 microns were included in further analysis.

The two powders had each been previously analyzed using the Morphologi to determine their corresponding size, shape and intensity distributions. These classifications determined which particles to target for Raman spectral acquisition.

Figure 3 shows the Morphologi software interface in which the particle thumbnails are displayed along with a scatter plot interface. This tool allows the distribution of two user-selected parameters to be visualized. In this example, particle size (CED) is plotted on the x-axis and circularity is plotted

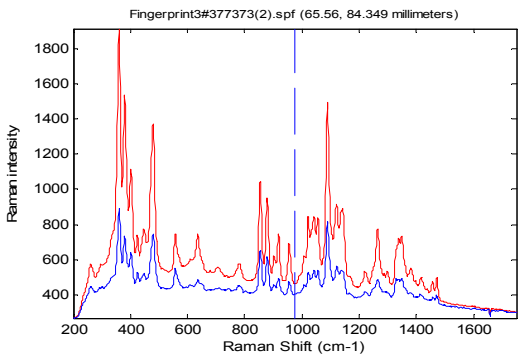

Figure 2: Raman spectra (blue trace) from particle (# 37,373) and suspect powder reference spectrum (red trace). Particle was targeted for spectral analysis based on morphological similarities to the suspect powder.

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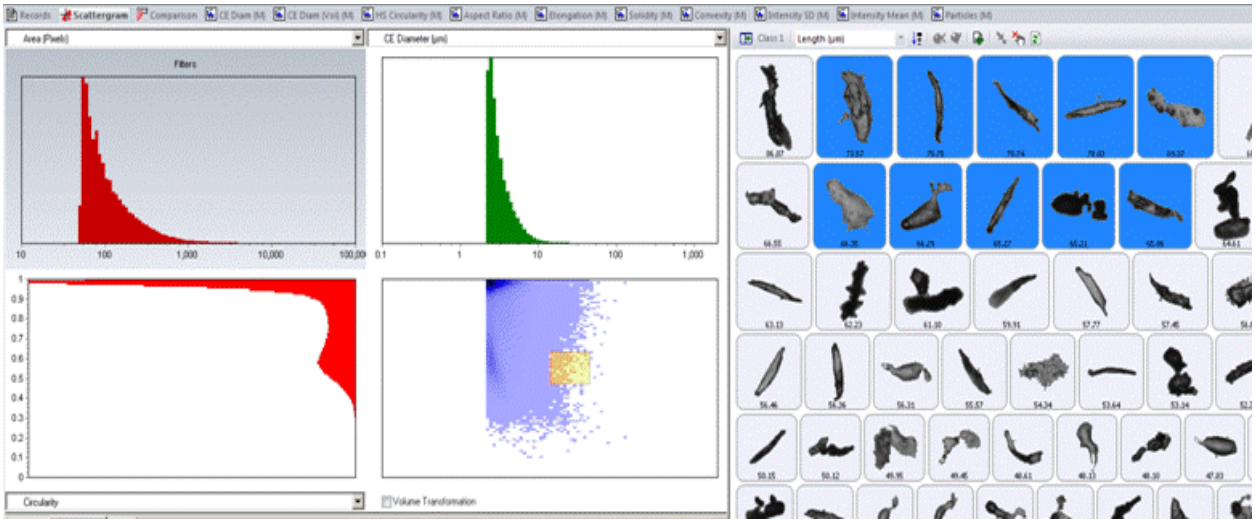

Figure 3: Morphologi software user interface highlighting elongated particles.

on the y-axis. Each blue dot therefore represents the circularity vs size for each of the tens of thousands of single particles.

Fibers and elongated particles are automatically excluded from chemical analyses, as their morphology does not fit the profile of the suspect powder.

Raman spectra were acquired with a 5 sec integration time. The excitation wavelength and power were 785 nm and ~15 mW at the sample, respectively, delivered through a 50X optic.

The spectral acquisition proceeds as follows: the Morphologi software drives the stage to the coordinates of the target particle, verifies the target, and acquires a Raman spectrum. The particle spectrum is appropriately pre-processed to minimize non-chemical effects, and then is correlated against spectra in a library. The correlation between the particles and library components (corresponding to chemical ID) can be used to sort and classify the particles. The spectra of all target particles are saved in the data file along with the associated morphological parameters.

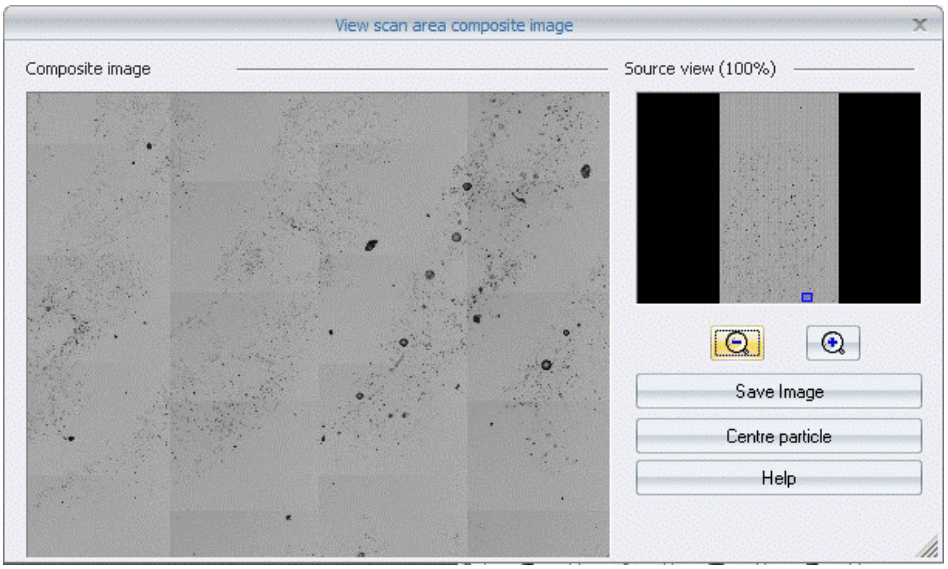

Figure 4: Spatial location of a particle chemically identified as the target chemical.

As the relative spatial location of the particles is preserved, the physical distribution of the particles can be analyzed to provide additional information.

Figure 4 shows the spatial location of one of the particles identified as the target chemical. Interestingly, it is close to the end of the distal phalange of the thumb, an area that was probably not carefully wiped if the thumb was not in full extension.

Conclusions

This short note describes the use of the Morphologi G3 with Raman micro-probe for the detection of suspect chemicals in a fingerprint.

This is only one of many examples of applications where chemical identification is desired for small particles present in a sample mostly containing empty space. The combination of automated particle imaging and advanced classification tools to target particles for chemical analysis represents a dramatic increase in efficiency for this type of chemical identification.

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