APPLICATION NOTE

1064 nm Dispersive Raman for Ink and Paint Classification

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Forensic examination often demands versatile analytical techniques with high specificity, high accuracy, and direct measurement ideally with little sample preparation, non-destructive and non-contact. Raman proves to be by far the most suitable analytical tool that can satisfy these essential criteria. Coupled with microscope, it is capable of identifying trace forensic evidence in micro-scale with direct chemical specificity.

Raman spectroscopy is an *in situ*, non-invasive, and sensitive technology to probe and analyze chemical compositions and structures with high specificity, in a near real-time manner. As a non-contacting optical method, it essentially does not require sample preparation. Coupled with an optical microscope, the Raman imaging technique has been successfully implemented quantitatively to analyze samples' composition at micro-scale.

Although been used for almost a hundred years, Raman spectroscopy is not vastly applied in forensics in the past, mainly because most "real-world" samples have a vivid color, which can be a background emission (fluorescence) thousands times stronger than Raman effect, when illuminated by light. This emission blinds the Raman signal carrying the chemical-specific information. These samples include most plant-based (e.g., cloth fiber, paper, leaves, pollen), bio-based (e.g., tissues, blood, serum), and man-made materials (e.g., ink, color dyes, explosives). When illuminated with visible laser light used for Raman spectroscopy, they generate fluorescence which limits the usefulness of Raman technique in the forensic analysis.

A fundamental way to avoid the fluorescence issue is to move to near-infrared laser such as 1064 nm, which is out of the excitation range of the most fluorescent samples. Due to technical limitations, in the past, 1064 FT-Raman has been the only solution to suppress the fluorescence. But it is a bulky instrument relatively cumbersome to use with constant moving parts and long acquisition time, and does not provide high-resolution spatial information.

Now, with the advances in solid-state lasers and fast detectors, Raman technique has been improved dramatically with the easiness of operation, fast speed, and less cost. BaySpec, Inc. has developed a new class of 1064-nm dispersive Raman spectrometers and microscopes with highly-efficient, patented Volume Phase Gratings (VPG®), fast optics, and deep-cooled, sensitive InGaAs detectors. Without any moving parts, these compact 1064 Raman spectrometers feature high sensitivity, high spectral resolution, and stability. Ultimately, 1064 Dispersive Raman is the solution for the most complex forensic analysis especially when high fluorescence often obscures the Raman signal. A few sample measurements are demonstrated below.

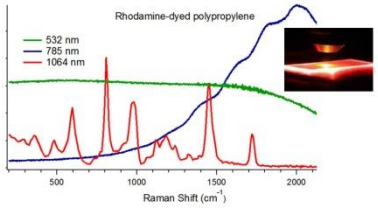

Figure 1. In real-world, most materials are colored. 1064 nm is perfect for Raman spectroscopy of colored materials (shown here is a piece of rhodamine-dyed plastic slide).

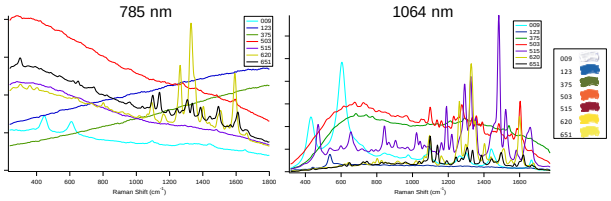

Figure 2. Most paint and ink, or even just some white paper, are highly fluorescent under visible laser illumination. Only 1064-nm excitation produces high-quality, signature-rich Raman spectra for these samples. Shown here are 785 and 1064-nm Raman spectra of some oil paints.

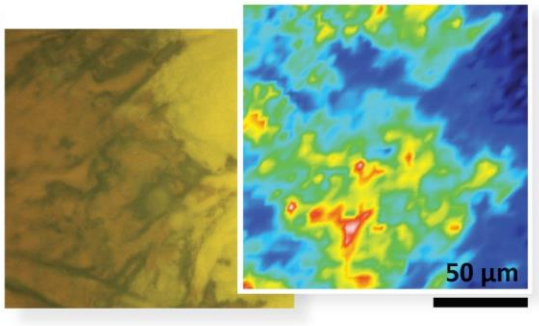

Figure 3. Chemical analysis and classification of black ink on paper using BaySpec's ***Nomadic***™ Raman microscope with 1064-nm Raman mapping, which can identify traces of highly-fluorescent materials for applications such as in forensics.

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