W04 Applications of Raman Spectroscopy for Trace Evidence Examinations

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This presentation focuses on applications of Raman spectroscopy for the analysis of various types of materials that may be encountered as trace evidence. This presentation is intended to provide trace evidence examiners with a better understanding of this underutilized analytical method, which has seen significant developments in instrument technology in the past couple of decades. After attending this presentation, attendees will gain: (1) a better understanding of the theory, principles, and instrumentation of Raman spectroscopy; and, (2) a greater appreciation of Raman spectroscopy's capabilities and limitations for the characterization, comparison, and identification of various types of trace evidence.

This presentation will impact the forensic science community by increasing participant knowledge and information as well as providing a framework upon which examiners can better utilize this method for casework and to correctly interpret the spectral data of their evidence.

The principles and applications of Raman spectroscopy for the analysis of various materials encountered as trace evidence are presented in this workshop. The emphasis is on spectral interpretation and explanations of the underlying reasons as to why Raman and infrared spectra differ. Because the two methods present data in formats that — superficially, at least — appear identical, the differences between the two methods are often a source of confusion.

All instructors of this workshop have experience as both trace evidence examiners and as researchers who have sought new applications of Raman spectroscopy. Collectively, the types of materials they have examined with this technique include textile fibers, paint, polymers, pigments and dyes, cosmetics, explosives, nanoparticles, and general unknowns. These instructors thus provide perspectives as both practitioners and researchers who have applied Raman spectroscopy for the analysis of a wide variety of materials.

Probably the most significant development that permitted the practical utilization of the very weak Raman effect, which consists of inelastic scattering from a sample, has been the advent of stable lasers, which provide intense monochromatic excitation sources. Use of such lasers for Raman spectroscopy began in the 1970s, and since that time, there have been a number of other significant developments in commercial Raman instrumentation. These include holographic gratings, Charge-Coupled Device (CCD) detector arrays, efficient notch and edge filters to remove Rayleigh scattering lines (without which Fourier Transform (FT) -Raman spectroscopy would not be possible), lasers covering a wide range of excitation wavelengths, and microscope attachments that allow spectral data to be collected from diffraction-limited spatial areas. These developments have transformed what was once a time-consuming analysis requiring hours to one in which data can now be obtained in minutes. More importantly, the lower laser power levels now permitted have expanded the range of materials from which useable Raman data can be obtained without destroying samples.

Because certain types of trace evidence may consist of very complex matrices, a battery of analytical techniques is typically employed to obtain more complete information about the sample. The types of information provided by a Raman analysis of various types of evidence are described, with particular emphasis on how this complements, supplements, or augments data obtained from other methods. Using Raman spectroscopy, trace examiners can probe very small areas of their evidence with minimal sample preparation in a non-destructive manner. Raman spectroscopy is thus ideally suited for the analysis of certain types of trace evidence, but it is currently an underutilized technique in the forensic science laboratory. This workshop is intended to help rectify this situation.

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