

# Raman Spectroscopy: Fundamentals, Apparatus, and Applications in the Characterisation of Illicit Drugs

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## EDITORIAL

Spectroscopy is the study of electromagnetic radiation's interaction with matter. Emission, absorption, fluorescence, and scattering phenomena can all be used in spectroscopic approaches. For the characterization of a wide range of forensic samples, various spectroscopic approaches are routinely used. These procedures are used to analyse samples qualitatively and quantitatively. The qualitative analysis is used to determine the sample's identification, whereas the quantitative analysis is used to determine the analyte concentration in the sample. Some spectroscopic methods (e.g. UV-Vis Spectrophotometry) are used as screening methods because they provide a tentative identification of the sample and are not specific, whereas others (e.g. Infrared Spectroscopy and Mass Spectrometry) are used as confirmatory methods because they provide a reliable identity of the sample and are specific. Some spectroscopic methods (for example, UV-Vis Spectrophotometry) are used as screening methods because they provide a tentative identification of the sample but are not specific, whereas others (for example, Infrared Spectroscopy and Mass Spectrometry) are used as confirmatory methods because they provide a reliable identity of the sample and are specific. Raman spectroscopy was named after its inventor, C.V. Raman, who co-authored the first publication on the technique with K.S. Krishnan. Raman Spectroscopy (RS) is a versatile technique for analysing a variety of forensic evidence. It overcomes the majority of the drawbacks of existing spectroscopic techniques. It has the ability to be utilised for both qualitative and quantitative purposes. The frequency of scattered radiations can be measured for qualitative study, while the intensity of scattered radiations can be measured for quantitative analysis. An evaluation of Raman spectroscopy's utility in the forensic investigation of several types of inks in questioned documents is now accessible. A summary of recent advancements in employing Raman spectroscopy to characterise trace levels of bodily fluids is given. A new review addressing the use of infrared and Raman spectroscopy in explosives identification is also available. Infrared spectroscopy is a companion technique to Raman spectroscopy, and it is addressed in many circumstances just to be thorough. The basic principle and instruments of Raman spectroscopy are

discussed in this article. The main goal of this review is to give a quick overview of some of the most relevant recent and selected Raman spectroscopy applications in the analysis of drugs of abuse and associated illegal substances. A scattering technique is Raman spectroscopy. It works on the basis of the Raman Effect, which states that the frequency of a small fraction of scattered radiation differs from the frequency of monochromatic incident light. It is based on incident light dispersing inelastically as it interacts with vibrating molecules. It uses molecular vibrations as a probe. In Raman spectroscopy, a monochromatic laser beam is used to illuminate the sample, which interacts with the molecules and produces scattered light. A Raman spectrum is made up of scattered light with a frequency that differs from that of the incident light (inelastic scattering). Raman spectra are produced by the inelastic interaction of incoming monochromatic light with sample molecules. When monochromatic radiation impacts a sample, it scatters in all directions after interacting with the molecules in the sample. Rayleigh scattering occurs when the frequency of dispersed radiation is equal to the frequency of incident radiation. Raman scattering occurs when a small fraction of scattered radiation has a frequency that differs from that of incident radiation. Stokes lines arise in the Raman spectrum when the frequency of incident radiation is higher than the frequency of scattered radiation. Anti-Stokes lines arise in the Raman spectrum when the frequency of incident radiation is lower than the frequency of scattered radiation. The measurement of scattered radiation is normally done at a right angle to the incident radiation. Because Stokes shifted Raman bands involve transitions from lower to higher energy vibrational levels, they are more intense than anti-Stokes bands and are thus measured in conventional Raman spectroscopy, whereas anti-Stokes bands are measured with fluorescing samples because fluorescence interferes with Stokes bands. The magnitude of Raman shifts is independent of incident light wavelength. The wavelength of incident light affects Raman scattering. To obtain a Raman spectrum of a sample, a change in polarizability during molecular vibration is required. Water is a suitable solvent for dissolving materials because it has minimal Raman scattering. In a Raman spectrophotometer, glass can be utilised for optical components such as mirrors, lenses, and sample cells. Dispersive

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and non-dispersive Raman spectrophotometers are available. Non-dispersive Raman spectrophotometers utilise a prism or grating, whereas dispersive Raman spectrophotometers use a prism or

grating. An interferometer, such as the Michelson interferometer in Fourier analysis, is used in the Raman spectrophotometer.