A149 Raman Laser Polarization and Its Effect on Fiber Analysis

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After attending this presentation, attendees will have an understanding of the application of Polarized Raman spectroscopy for fiber identification and characterization. In addition, this presentation will introduce the phenomenon of how the polarization of a Raman laser affects the Raman spectrum of synthetic fibers.

This presentation will impact the forensic science community by providing an alternative approach to distinguish and discriminate between synthetic fibers since the Raman laser polarization effect on synthetic fibers has never been explored in the forensic community.

Fibers are a frequently encountered form of trace evidence. Many techniques and types of instrumentation have been developed and used to analyze fibers in the forensic community, for example, the comparison microscope, the fluorescent microscope, the polarized light microscope, the UV-Vis micro-spectrometer and the FTIR micro-spectrometer. Each of these techniques is capable of providing unique and useful information about a fiber.

Recently, Raman spectroscopy has started to establish its place in the forensic science community. Raman spectroscopy has been used to analyze paint chips, inks, drugs, condom lubricants, and dyes. The growth of Raman spectroscopy in the forensic science community is due to its short analysis time, minimum sample preparation, and non-destructiveness. Many articles published on fiber analysis have indicated that Raman spectroscopy is useful for identifying the dye(s) in the fiber. However, Raman spectroscopy should also be explored for fiber type identification and characterization.

Like Infrared spectroscopy, Raman spectroscopy yields vibrational spectra that indicate the chemical structure of a material. Raman spectrometers are often equipped with a polarized laser source. As in polarized light microscopy, the polarized laser interacts with different orientations of an anisotropic material. A drawn out fiber exhibits pseudo crystallinity that can be exploited by the polarized Raman laser source to yield additional information on the chemical structure of the fibers. This information may be useful in forensic fiber analysis. Depending on the orientation of the fiber, the polarized laser can interact differently with the functional groups of the fiber, producing a slightly different Raman spectrum for a given fiber orientation. Depending on the type of fiber, the difference can be seen in relative peak intensities, and additional peak(s).

Polyester, nylon, and acrylic fibers were analyzed with a WITec Confocal Raman Microscope with a 532 nm polarized laser source in this study. Five fibers for each fiber type were analyzed to ensure representativeness. Each fiber was measured in its perpendicular and parallel orientation with respect to the polarization of the laser source. For polyester fiber, dramatic differences were observed when comparing the perpendicular and parallel orientation at the 2800 cm^{-1} to 3000 cm^{-1} range. The peaks in the perpendicular orientation have relatively higher peak intensity. In addition, it has four distinguished peaks instead of three in the parallel orientation. The overall pattern of the peaks in that region is completely different. Minor changes were also observed in the 1300 cm^{-1} to 1400 cm^{-1} region, there are four peaks for the perpendicular orientation and two for the parallel orientation. For acrylic fiber, the only noticeable change observed was at peak position 1220 cm^{-1}, that peak was there in the parallel orientation and disappeared in the perpendicular orientation. For nylon fiber, the N-H stretching at 3305 cm^{-1} is relatively more intense in perpendicular orientation. In addition, there is an extra peak at about 1550 cm^{-1} in the parallel orientation. Also, the relative intensity of peaks at 1435 cm^{-1} and 1630 cm^{-1} were switched in the two different orientations. All the differences are due to the interaction between the polarized Raman laser and the different pseudo crystalline orientation of the fibers.

This preliminary study focuses on the most common synthetic fibers. Future studies can be conducted with different laser wavelengths and natural fibers.

Raman, Polarization, Fiber