B166 The Discrimination of Colored Acrylic, Cotton, and Wool Fibers Using Raman Spectroscopy

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After having attended this presentation, attendees will understand the advantages and limitations of Raman spectroscopy for the analysis of one of the most common mass produced items of forensic interest—textile fibers.

This presentation will impact the forensic science community by showing the application of one of the analytical methods that in the last years has created a remarkable interest in forensic laboratories. This technique is Raman spectroscopy.

This work concerns the application of one of the analytical methods that in the last years has created a remarkable interest in forensic laboratories. This technique is Raman spectroscopy.

Such a method has been recently revaluated for its application in forensic science for the chemical analysis of several types of materials. The Raman technique allows for the measurement of the inelastic scattering of light due to the vibrational modes of a molecule when irradiated by an intense monochromatic source such as a laser. The Raman technique presents enormous advantages, including its non-destructive nature, its short analysis time, and the possibility of performing microscopic *in situ* analyses. In its forensic application, it is a versatile technique that covers a wide spectrum of samples such as explosives, hazardous materials, drugs of abuse, trace evidence, and inks.

The potential of the Raman technique was demonstrated in the analysis of textile fibers too. Raman spectroscopy allows for the detection of dyes used in the coloration of such samples.

In this project, 180 samples were randomly collected: 60 acrylics (20 blue, 20 red, and 20 black), 60 cotton (20 blue, 20 red, and 20 black), and 60 wool samples (20 blue, 20 red, and 20 black). Four laser excitation sources were tested: argon ion laser at 514 nm, helium-neon at 633 nm, and two near infrared (NIR) diode array lasers at 785 and 830 nm. The advantage of using several laser wavelengths was also emphasized in the forensic Raman analysis of fibers. Several aspects were investigated according to the best analytical conditions for every type/color fiber combination. The results show that NIR lasers provide better results for acrylic fibers (all colors) and for red cottons and wools and blue laser (514 nm) is more adapted for blue and black cotton and wool. It was also observed that some lasers were inefficient for some fiber classes (e.g., He-Ne for acrylics and Argon for red fibers). Interference from the support (due to the fiber type) was not observed for acrylics, and only the information about the dyes was detected. On the other hand, for few cotton and wool samples, Raman bands attributed to cellulose and keratin respectively were observed. They did not hide the information attributed to the fiber dyes. The information about the fiber dye was systematically observed.

In this project, particular attention was placed on the discriminating power of the technique. Based on the results from the Raman analysis, it was possible to obtain different classes of fibers according to the general shape of spectra, but particularly, on the basis of additional bands. Raman spectroscopy was not considered as an isolated technique but rather as a step in the conventional analytical scheme for textile fibers. Thus, in order to optimize the analytical sequence, it was determined at which stage Raman spectroscopy should be integrated and under which conditions. For this purpose, the collected samples were also analyzed by light microscopy (bright field, double polarization, and fluorescence), UV-UV-Vis microspectrophotometry (MSP) and thin layer chromatography (TLC). This research showed that Raman spectroscopy plays an important role in the detection and identification of the main dyes used for the impregnation of fibers. UV-Vis microspectrophotometry showed the best discriminations for every type of analyzed fibers, while in some cases, the Raman technique allowed for further discriminations after MSP. In terms of discriminations, Raman spectroscopy was affected by two main factors. The first was fluorescence, and the second was the fact that some spectra configurations occurred frequently and thus the variation in a given set of 20 samples was low. Given the potential of Raman spectroscopy for identification purposes, the realization of an extended spectral library of reference dyes is an ambitious but useful aim from an operational perspective.

Trace Evidence, Raman Spectroscopy, Fibers