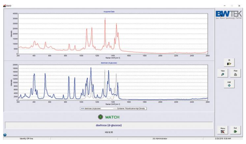
Identification of Forensic Fabrics Using a Portable Raman Spectrometer

Introduction

At a crime scene, a police officer collects a fiber sample that may prove to be invaluable evidence in identifying a criminal or exonerating an innocent person. While FTIR has been used for analysis in the past, the strong absorption of the fabric or the glass slide where it is mounted makes the spectrum very hard to interpret. In recent years, Raman spectroscopy has been studied extensively for forensic fiber analysis because of the high selectivity of Raman signatures, non-destruction nature of the test, and the ability to conduct the analysis without any sample preparation. The Raman test can be performed directly on fabrics or fibers mounted on glass slide with very little interference from the mounting resin or the glass.

Configuration



BWT-840000126 - BWID Standard Raman ID Software
Data acquisition, material identification and reporting software for B&W Tek portable Raman spectrometers to rapidly identify or verify materials based on user-built libraries, proprietary B&W Tek and third-party libraries. Includes system performance tests. One user license provided. Free upgrades included within one year of purchase date.

BWT-840000985 - Raman Video Micro-Sampling System (1064 nm)
Video microscope sampling system for use with B&W Tek's lab and industrial Raman probes. Includes a 20x objective at a working distance of 16 mm. Offers manual rough and fine adjustment on the X, Y, and Z-axes, coaxial LED illuminator for target alignment, video camera for sample observation, and is compatible with standard microscope objectives. Probe not included, available separately. 1,064 nm configuration.BAC151C-1064

Experimental

In this study, six types of undyed fabric samples were tested: diacetate, bleached cotton, polyester, polyamide (nylon), acrylic, and wool. A B&W Tek i-Raman EX portable Raman spectrometer with 1064 nm laser excitation along with a fiber optic probe holder was used. The video microscope sampling accessory can be used for testing on thin fibers and is very useful for microsamples, and for looking at specific spots on a sample.

The identification test involves creating a library and comparing each individual fabric spectrum with the spectra in the library. The software BWID was used to generate the library as well as to conduct the identification. The resulting “Match” or “No Match” is based on HQI (hit quality index), which measures the level of correlation of the sample spectrum against a reference spectrum calculated by using the correlation coefficient algorithm. The HQI threshold for a “Match” result was set at 80, which indicates an 80% correlation score between the sample spectrum and the reference spectrum.

Four out of the six types of fabrics are unambiguously identified. The overlaid spectra for these four fabrics are shown in **Figure 1**. As demonstrated in the diagonal line in the comparison results of **Table 1**, there is clear differentiation to separate diacetate, bleached cotton, polyamide, and acrylic fabrics.

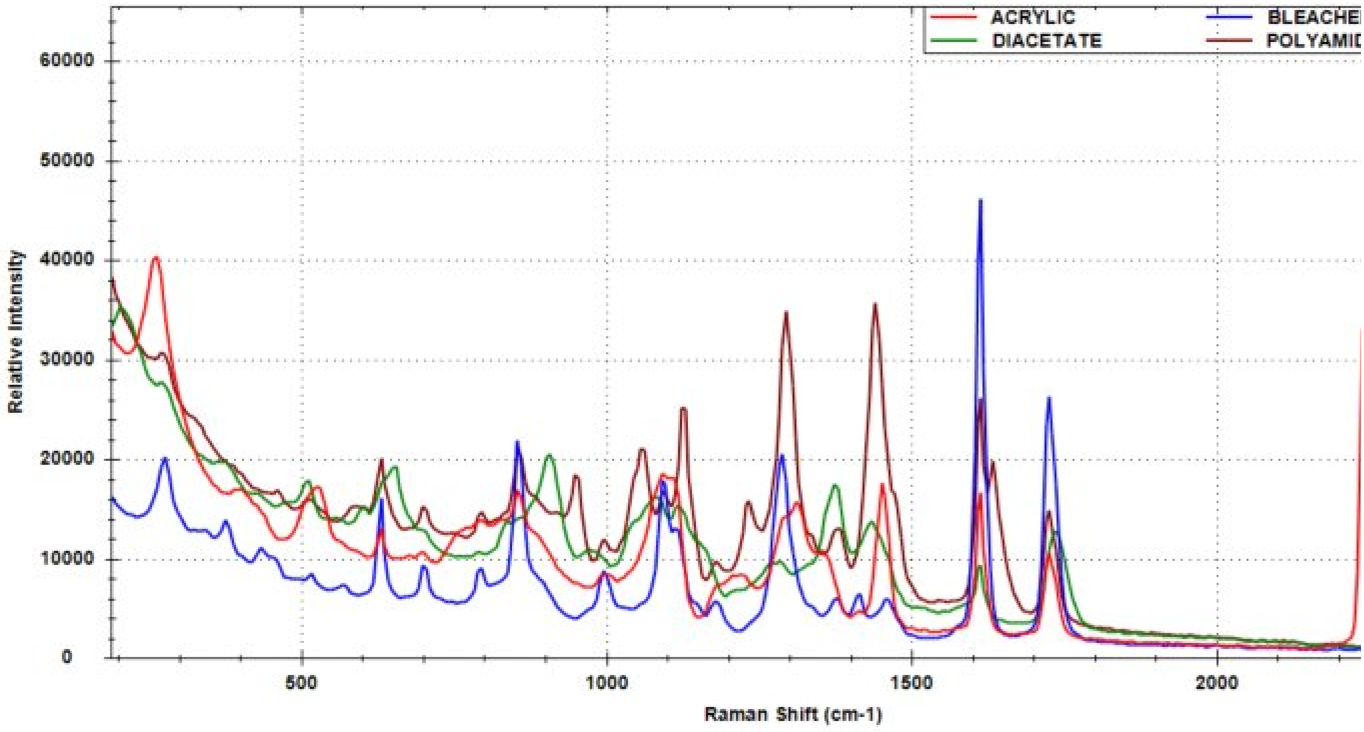


Figure 1. Overlay of spectra for acrylic, bleached cotton, polyamide, and diacetate

Library / Sample	Diacetate	Bleached Cotton	Polyamide	Acrylic	Polyester	V
Diacetate	Match (HQI=87.68)	No match	No match	No match	No match	No m
Bleached Cotton	No match	Match (HQI=94.08)	No match	No match	No match	No m
Polyamide	No match	No match	Match (HQI=91.98)	No match	No match	No m
Acrylic	No match	No match	No match	Match (HQI=93.97)	No match	No m
Polyester	No match	No match	No match	No match	Match (HQI=96.59)	2nd (HQI
Wool	No match	No match	No match	No match	2nd Match (HQI=94.75)	M (HQI

Table 1. Identification results using BWID software

Polyester and wool are difficult to differentiate by HQI, as the Raman spectra are highly similar (**Figure 2**). However, since fibers made from animal hair contain protein keratin, an amide I band from the amino acid cysteine in the region from 1600-1690 cm^{-1} would be expected[**1**] for wool and not polyester. In addition, since cysteine provides the disulphide crosslinks that hold the polymer chains in wool, a disulphide S-S band at 523 cm^{-1} would also be expected[**1**]. These two peaks that are distinctively related to animal proteins can be seen in the wool spectrum shown in **Figure 2**, with the amide I band at 1653 cm^{-1} and the S-S band at 523 cm^{-1} . These two unique peaks can be used to differentiate wool from polyester.

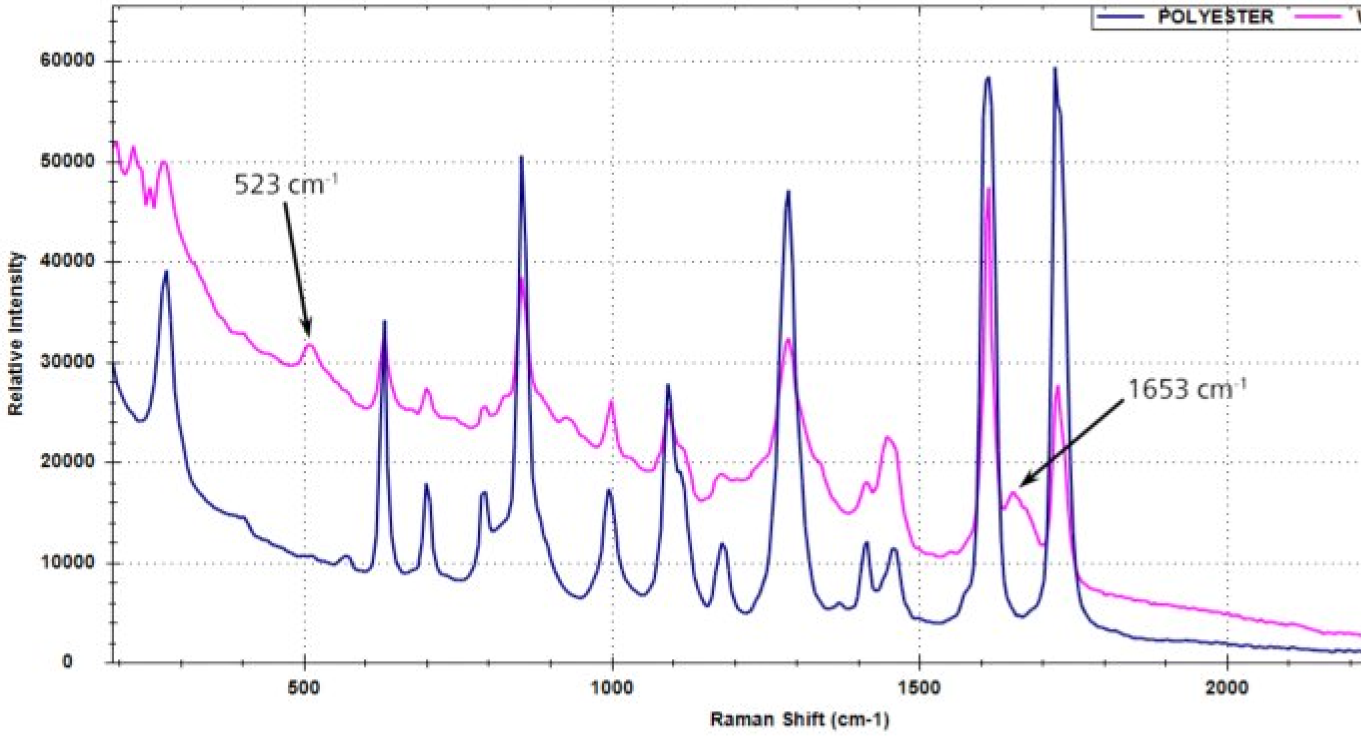


Figure 2. Overlay of spectra for wool and polyester

Conclusion

With unique discrimination power, Raman spectroscopy is a powerful technology that can be applied to forensic fabric and fiber analysis. Identification of an unknown fabric is achieved in several minutes, making it a practical choice for rapid identification either on site or in the forensic lab.

Reference

1. Li-Ling Cho. Identification of textile fiber by Raman microspectroscopy. J Forensic Science 2007; 6 (1):55-62

Metrohm AG

mailto:info@metrohm.com

Ionenstrasse

9100 Herisau