Identification of Forensic Fabrics Using a Portable Raman Spectrometer

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.

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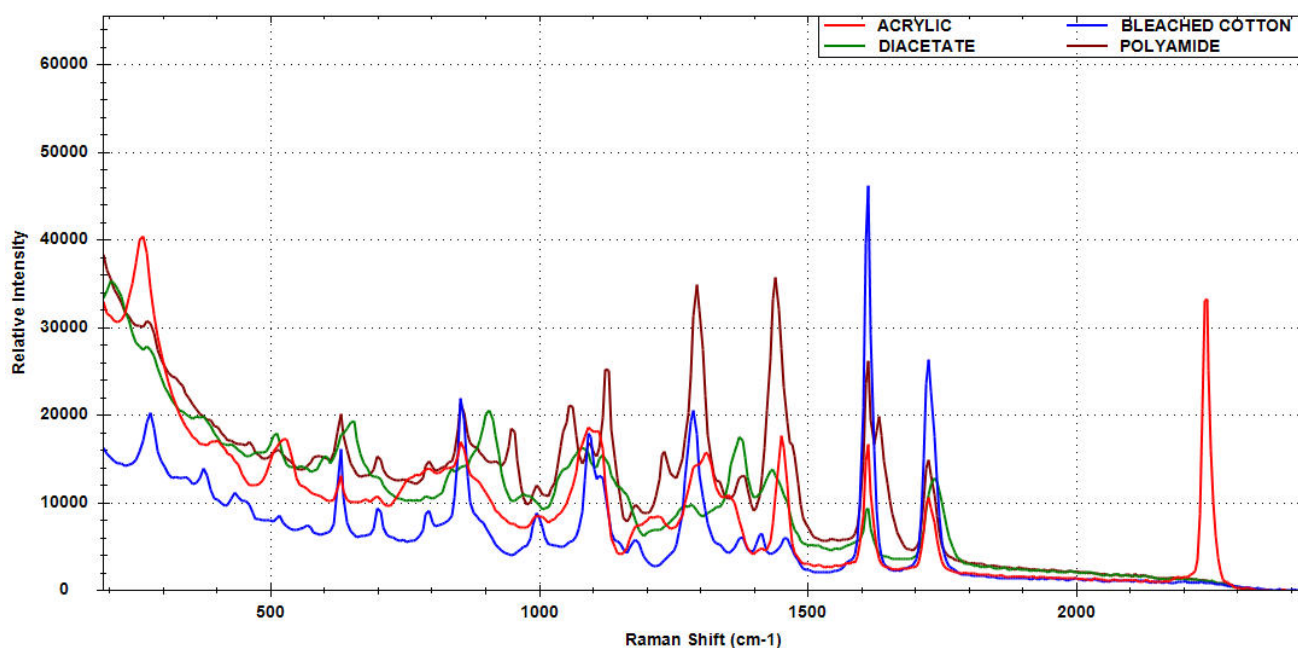
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Figure 1. Overlay of spectra for acrylic, bleached cotton, polyamide, and diacetate

Library⁄Sample	Diacetate	Bleached Cotton	Polyamide	Acrylic	Polyester	Wool
Diacetate	Match (HQI=87.68)	No match	No match	No match	No match	No match
Bleached Cotton	No match	Match (HQI=94.08)	No match	No match	No match	No match
Polyamide	No match	No match	Match (HQI=91.98)	No match	No match	No match
Acrylic	No match	No match	No match	Match (HQI=93.97)	No match	No match
Polyester	No match	No match	No match	No match	Match (HQI=96.59)	2nd Match (HQI=81.23)
Wool	No match	No match	No match	No match	2nd Match (HQI=94.75)	Match (HQI=85.38)

Table 1. Identification results using BWID software

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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.
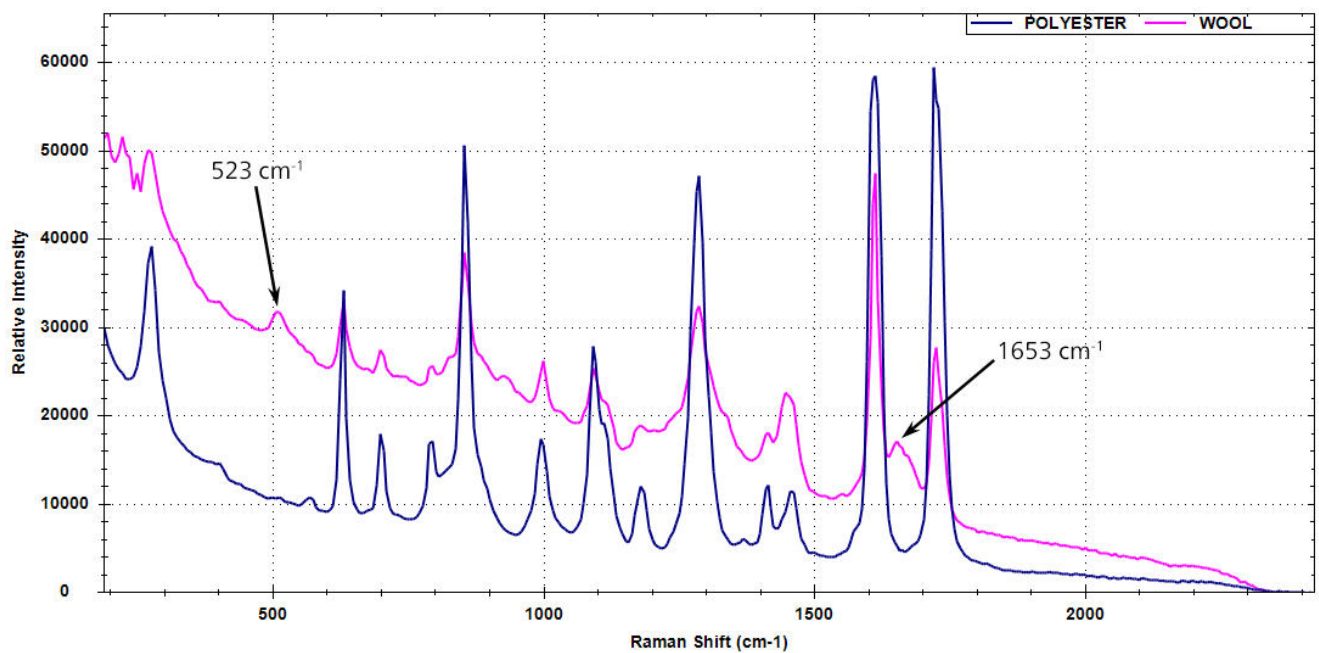

Figure 2. Overlay of spectra for wool and polyester

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.
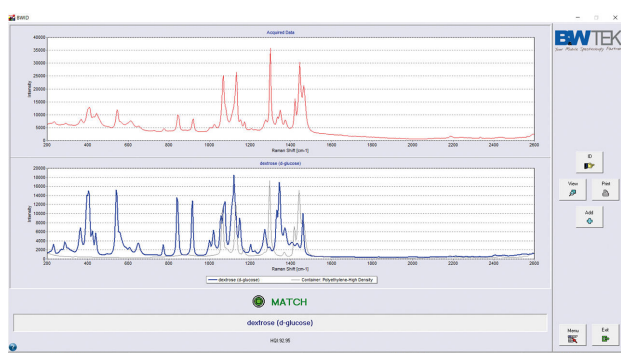
REFERENCE

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

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CONFIGURATION

BWID ID

ユーサーか作成したライフラリ、著作権て保護された B&W Tek のライフラリ、ならひに第三者フロハイタのライフラリに基つく材料の迅速な識別または検証を可能にする、B&W Tek 社製 携帯型ラマンスヘクトロメーターのためのテータ記録、材料識別、およひレホート作成のためのソフトウェア。システムの性能検査を含みます。ユーサーライセンスを包括。購入日より1年間の無料アッフクレートを含みます。

(1064 nm)

ラホおよひ産業用のB&W Tek社製ラマンフローフを用いた使用のためのヒテオマイクロスコーフ付きサンフル採取システム。作動距離16 mmて20倍拡大の対物レンズ付き。X、Y、およひZ軸方向の粗調整ならひに微調整、ターケティンク用同軸LED照明、サンフル観察のためのヒテオカメラか使用可能てあり、標準マイクロスコーフ対物レンズと互換性かあります。フローフは含まれておらす、個別にこ購入いたたけます。1064 nmコンフィクレーション。

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