HARRICK SCIENTIFIC PRODUCTS

No. 41109

IDENTIFICATION OF UNKNOWN FIBERS USING DIAMOND ATR SPECTROSCOPY

Figure 1. The VideoMeridian™ viewing diamond ATR with optional video display.

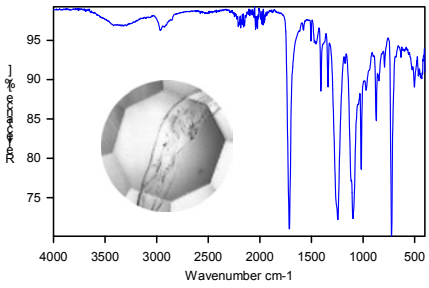

Figure 2. ATR spectrum of a fiber from a neutral-colored flat-weave rug.

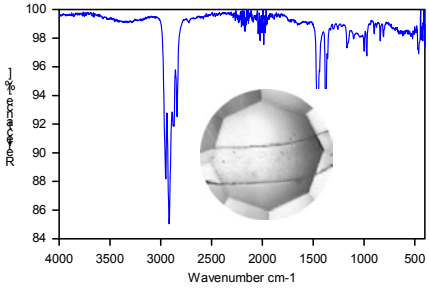

Figure 3. ATR spectrum of a fiber from a neutral-colored tufted rug.

INTRODUCTION

Identification of known fibers and hairs is vital for forensic and crime scene investigations. In these applications, it is critical to have quick, straightforward and accurate methods of analysis with as much documentation as possible. Having the ability to analyze samples in a timely manner can be crutial to a forensics case.

Infrared ATR spectroscopy is an excellent method for identification of such materials. ATR microsamping accessories, combined with the high signal-to-noise ratios of today's FTIR spectrometers, make a powerful tool for examining small samples like fibers and hairs. Furthermore, some of these ATR accessories are now equipped with digital imaging capabilities, simplifying photographic documentation of the samples investigated.

In this applications note, several unknown fibers are examined using Harrick's VideoMeridian™ diamond ATR micro-sampler. Both spectra and digital images are documented. The former are used to identify the composition of the samples, and the latter are exact images of the samples analyzed.

EXPERIMENTAL

Unknown fibers were collected from common household materials. Individual fibers were extracted from rugs and clothes, and an imbedded fiber from a U.S. twenty-dollar bill. These were examined using the VideoMeridian™ with its type IIA diamond ATR crystal (Figure 1) in an FT-IR spectrometer. All spectra were collected with 32 scans at 4 cm^{-1} resolution and a DTGS detector.

Background single beam spectra were collected using the clean diamond ATR crystal. Then the samples were centered on the ATR crystal, using the video display, and the samples were compressed against the diamond with 15 units of pressure on the display. Next, the sample spectra and corresponding digital photo-graphs were collected. Data collection typically took 2.5 minutes, for an experienced operator.

The spectra were then processed through an FT-IR ATR library for identification of the samples. The ATR crystal was cleaned with methyl ethyl ketone between samples.

RESULTS AND DISCUSSION

Figures 2 through 5 show spectra and digital image of the

applications note

FORENSIC IDENTIFICATION OF UNKNOWN FIBERS USING DIAMOND ATR SPECTROSCOPY

unsupported fibers, as measured with the VideoMeridian.

The spectra were all compared to on-file library spectra and the fibers were identified as follows. The fiber from the neutral-colored flat-weave rug, shown in Figure 2, is a polyester. The tufted rug fiber, whose spectrum appears in Figure 3, is a polyproplyene. The red fiber, shown in Figure 4, is a cotton-polyester blend, and the blue fiber in Figure 5 is made from nylon. Note that all the spectra have an increased noise level around 2100 cm^{-1}. This is due to incomplete compensation of the highly absorbing diamond lattice bands. Very few materials actually absorb in this small range and hence this does not significantly limit the use of this method for identification of materials.

From the digital photographs, it is clear that the diameters of the compressed fibers varied by roughly a factor of three. Since the sampled area on the VideoMeridain diamond is 500µm in diameter, it is possible to estimate the size of the compressed fibers. Figure 4 shows the thinnest fiber examined, and it was compressed to approximately 60µm in diameter.

In addition to free-standing fibers, imbedded fibers can also be examined and identified. Figure 6 shows the ATR spectra from two sections of the bill. One section has a noticeable blue fiber in it that, as deduced from the photograph (Figure 7), is approximately 65 µm in diameter. The other section was more uniform and examined as a reference. The bands at 1715 cm^{-1} and 1250 cm^{-1} appear in the spectrum of the fiber but not in the spectrum of paper. Subtraction results in a spectrum that can be clearly identified as polyester.

SUMMARY

As seen above, the VideoMeridian is a powerful tool for analyzing and identifying unknown fibers. Its video-imaging capabilities are useful both for positioning samples on the diamond ATR crystal and for maintaining photographic documentation.

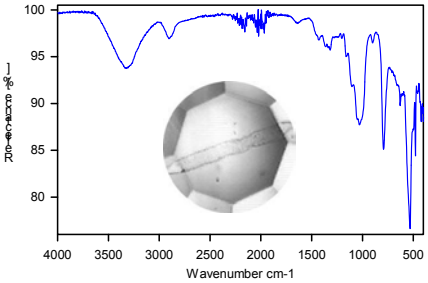

Figure 4. ATR spectrum of a red fiber.

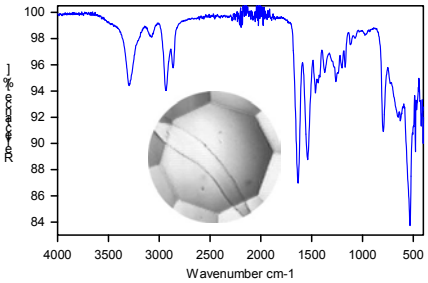

Figure 5. ATR spectrum of a blue fiber.

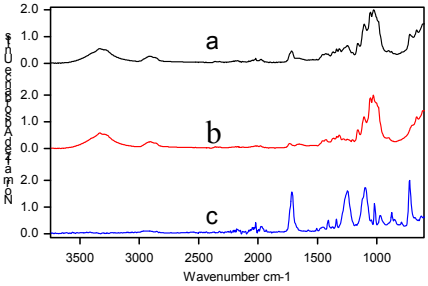

Figure 6. Normalized ATR Spectra of a blue fiber on the greenback (a), an area near that blue fiber (b) and the difference (c).

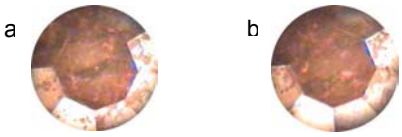

Figure 7. Photographs of the blue fiber on the greenback (a) and an area near that blue fiber (b). Spectra shown in Figure 6.

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