CASE REPORT

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Distinguishing Between New and Slightly Worn Underwear: A Case Study

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ABSTRACT: This case study relates to a suspect accused of shoplifting a pair of underwear briefs from a department store. The report presents a method that was used to distinguish between new and used underwear employing both laser examination for biological staining and microscopical examination for thread wear.

KEYWORDS: forensic science, criminalistics, seminal stain, fluorescence, microscopy, thread wear

From an observation area above the ceiling in a department store on the day after Christmas, a shopper was observed taking trousers into a fitting room. He left the fitting room and returned the trousers to a store counter, when it was noticed that a package that normally contained three sets of underwear briefs had been opened and contained only two sets of underwear. After leaving the store the suspect was arrested for shoplifting, strip-searched, and the underwear he was wearing was seized. The suspect claimed that the underwear he was wearing had been purchased from the store on a previous date.

Methods

Visual examination of the questioned underwear verified that it was the same brand as the underwear left on the counter; the underwear was white and did not appear stained but had a slightly gray tinge when compared to new underwear. Short-wave and long-wave illumination (thin-layer chromatography illumination lamp) showed similar blue-white fluorescence for both the unused and questioned underwear. The underwear from the suspect under laser illumination (green laser light excitation and orange plastic filter goggles) showed fluorescence spots similar to urine of different intensity and trace spots of an intensity commonly seen with seminal stains. This fluorescence is indicative of application of physiological fluids over a period of time. This observed staining is contrary to the short time that the suspect was accused of wearing the underwear. Stereomicroscopical examination showed traces of lint in the seams of the underwear worn by the suspect, as well as broken fibers in the fabric relative to the unworn underwear. Photomicrographs were taken of both underwear samples (Leitz "Aristophot" microscope camera system with 1.2× objective, 6.5× photographic ocular with bellows extension for 25× magnification, and top-light sample illumination using an external light source). The analytical results confirmed that the underwear of the suspect had been previously worn.

Discussion

An initial thought for distinguishing between the underwear samples was to attempt to check for detergent traces in laundered underwear. The ultraviolet illumination showed (as would be expected) that the new underwear had also been laundered so that an examination for detergents would be questionable.

There was some dulling of the fluorescence of the whiteners by seminal stains using both long and short-wave UV illumination but not enough to be conclusive. Using laser goggles to view the stained sample when long-wave UV lighting was used, slightly enhanced the staining; the results were still inconclusive. No difference was noted when the laser goggles were employed with short-wave UV illumination. The laser light source excitation of the sample is of interest since it excited fluorescence of the stains in the sample, which was not masked by the fluorescence of the whiteners. Whiteners are fluorescent dyes added to laundry detergents to hide dirt in the respect that whiteners emit "white" light upon short wavelength (ultraviolet light) excitation. For UV excitation the fluorescent spectra of whiteners from many fibers have been shown to span much of the visible range with maximums in the 430 nm area (1). Fluorescence excitation with the laser either was not exciting the fluorescence of the whiteners or the emitted fluorescent light of the whiteners was at a wavelength not in the bandpass of the filter (goggles).

By definition the fluorescence process begins with the absorption of light by molecules in the illuminated sample. The absorbed light has a wavelength corresponding to an energy difference between that of the energy levels in the ground electronic state and an excited electronic state for the molecules in the sample. These excited molecules then lose some energy (corresponding to collisional energy loss) to reach the ground state of the excited electronic energy level. This is prior to a return to the energy levels

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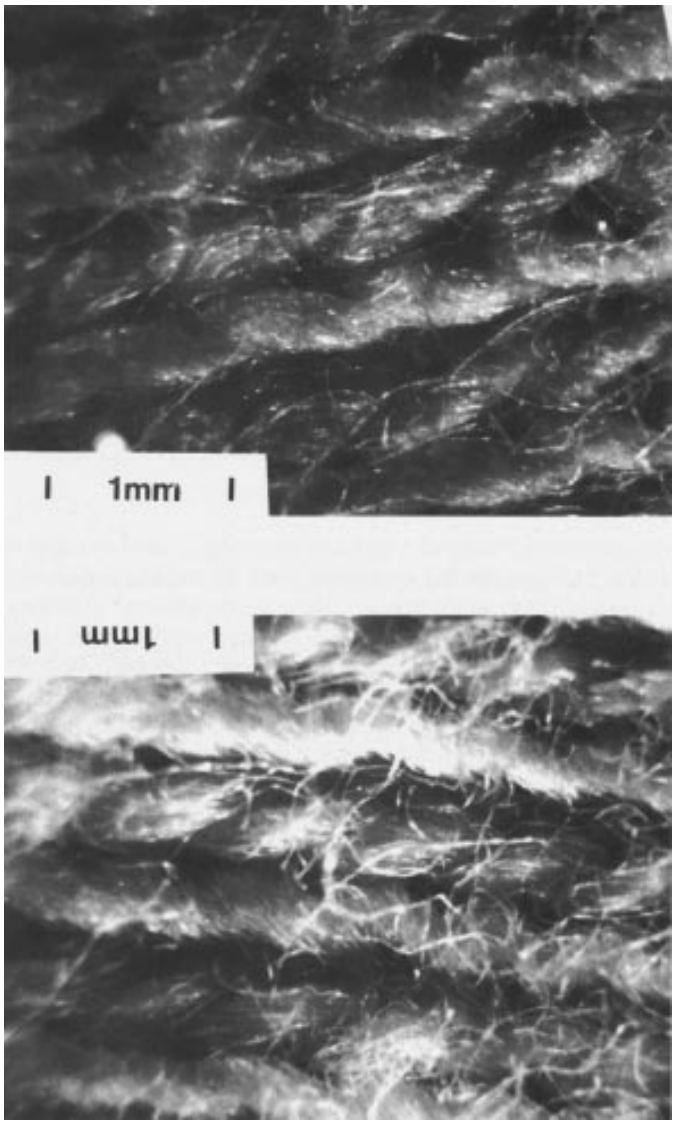

FIG. 1—*Photomicrographs of new (A) and worn (B) underwear.*

of the ground electronic state by an emission of light, the fluorescence. Consequently, the excitation light is of greater energy (shorter wavelength) than the emitted light (the observed fluorescence) (2). Thus the apparent contradiction: since the UV higher energy light causes excitation, how can the laser light which is green, monochromatic and lower energy cause excitation? The laser employed (Cooper Laser Sonics, Model 1510, 13 watts average power—firm no longer in business) provides green light at a wavelength of 510 and 578 nm. The peak pulse power is 90,000 watts at 40 nanosecond pulses. It is known that high energy laser sources produce a phenomenon known as double photon absorption (3). Calculation of the energy for double photon absorption using the Planck relationship, $E = h\upsilon$, for the green wavelengths emitted by the green laser showed that it would correspond to ultraviolet light emission of wavelengths at 255, 257, and 297 nm. It is likely that this light was capable of excitation of the biological materials without causing the excessive excitation of the detergent whiteners that masked any fluorescence of the biological materials as when the broad wavelength ultraviolet light source was employed. Also possible, is that the emission light from the whiteners was at a wavelength not in the bandpass of the orange laser filter (goggles). Stoilovic (4) reported on the fluorescence of semen. The work was performed primarily on filter paper because of its low background fluorescence. This is opposite to the condition of fabric treated with whiteners. He measured the excitation spectrum for the fluorescence of semen from 300 to 480 nm and suggested that fluorescence excitation might take place using a longer wavelength excitation source. It is possible that some excitation of the semen occurs at the green laser light wavelength, but due to the intensity of fluorescence by seminal stains it is reasonable that double photon absorption is the major contributor for fluorescent excitation.

Microscopical examination showed that new fabric had long, intact fibers making up each thread. As the clothing is used, laundering, wearing and other abrasive actions break fibers within the threads leaving frayed ends that were detected on microscopical examination. The presence of lint in the seams is indicative of prior use, and the seams would be the best place of find trace fibers from other fabrics via abrasion or laundering. The microscopical examination provided a second, independent method for distinguishing between slightly worn and unworn clothing (Fig. 1).

To the best knowledge of the authors, a similar problem of distinguishing between slightly worn and unworn clothing has not appeared in the forensic literature. For this particular case the method described was both quick and decisive. Situations in sexual assault cases may arise where the ability to correlate information of the age of a fabric to the presence of biological stains is useful. The method employed in this case can assist in the analytical thinking necessary for such situations.

References

1. Kubic TA, King JE, DuBey IS. Forensic analysis of colorless textile fibers by fluorescence microscopy. The Microscope 1983;31: 213–22.
2. Willard HH, Merrit LL Jr., Dean JA, Settle FA Jr. Instrumental methods of analysis. 7th ed., Belmont, CA, Wadsworth Publishing Co. 1988.
3. Friedrich DM. Two-photon molecular spectroscopy. J Chem Educ 1982;59:472–81.
4. Stoilovic M. Detection of semen and bloodstains using polilight as a light source. Forensic Sci Int 1991;51:289–96.

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