B151 UV-Visible and Fluorescence Microspectrophotometry for the Forensic Analysis of Fluorescent Brighteners on Textile Fibers

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The goal of this presentation is to determine the usefulness of UV-Vis and fluorescence microspectrophotometry of fluorescent brighteners on fibers for forensic fiber discrimination.

This presentation will impact the forensic community and/or humanity by demonstrating how fluorescent brighteners can be important for discriminating among seemingly similar white fibers. The absorbance and fluorescence of fluorescent brighteners on acrylic, cotton, nylon and polyester fibers can be detected and differentiated in Permount without significant interference from absorbance or fluorescence from the mounting material. C Different fluorescent brighteners from the same chemical subclass (e.g., pyrazolines) showed similar spectra that could also be differentiated.

Fiber evidence is frequently used in forensic science to associate a suspect to a victim or crime scene. “Questioned” fibers are collected from the crime scene and “known” fibers are collected from the suspect. Evidence fibers are collected through a combination of picking, scraping, vacuuming, and sometimes taping clothing and areas of the crime scene and are mounted in a mounting material on microscope slides for comparison and storage. Once the fibers have been collected, questioned and known fibers are compared using a series of microscopic techniques to determine whether or not the fibers could have come from the same source. The first of these methods is often polarized light microscopy (PLM). Using PLM, the generic fiber type (polyester, acrylic, nylon, cotton, etc.) is determined, and color, fiber cross-sectional shape and fiber thickness are compared. This analysis is often followed by fluorescence microscopy, and UV-Vis and fluorescence microspectrophotometry. If spectra of the known and questioned fibers match, the hypothesis that the fibers originate from a common source should not be rejected.

Many fibers not only contain dyes that absorb visible light (400-700 nm), but also optical brighteners, which absorb ultra-violet light (around 360 nm) and re-emit light as fluorescence within the visible spectrum (around 440 nm). These fluorescent dyes mask “yellowness” and can make fabrics appear “whiter than white.” Most of the attention in the analytical literature has been focused on fluorescent brighteners from detergents, with little attention being paid to fluorescent brighteners applied by the textile dyer. Fluorescent brighteners are often the only dyes present on white fibers. They are added to the melt during manufacture of staple polyester for blending with cotton. Textile dyers add fluorescent brighteners to impart whiteness to woven and knit products. Everyone who launders his/her clothing also adds fluorescent brighteners because they are in almost every brand of laundry detergent.

Fluorescent brighteners can therefore be important for discriminating among seemingly similar fibers. For this paper, nine different fluorescent brighteners from six different chemical subclasses were compared: one coumarin, two distyrylbiphenyls, one heterocycle, two pyrazolines, two stilbenes, and one thiophene oxazole. One objective of this study was to determine whether Permount®, a popular mounting medium for UV/vis spectrophotometric characterization, would result in loss of discriminatory spectral data for fibers dyed with fluorescent brighteners. To answer this question, slides of polyester, acrylic and nylon 6 fibers, with and without fluorescent brightener, were prepared using Permount and glycerin as mounting media on glass and quartz. Additionally, the possibility of discriminating between seemingly similar white fibers with different fluorescent brighteners based on their UV-Vis and fluorescence spectra was assessed.

The absorbance and fluorescence of fluorescent brighteners on acrylic, cotton, nylon and polyester fibers can be detected in Permount without significant interference from absorbance or fluorescence from the mounting material. Comparison of fluorescence spectra by visual analysis and multivariate data analysis showed that fluorescence microspectroscopy could differentiate between all 9 different fluorescent brighteners used in this study. Different fluorescent brighteners from the same chemical subclass (e.g., pyrazolines) showed similar spectra that could nevertheless still be differentiated. In the case of cotton and nylon, fluorescent brighteners from detergents may increase the discrimination. Fluorescent brighteners contained in the detergent tested, however, did not show substantivity for polyester and acrylic fibers.

Overall, UV-Vis and UV-fluorescence microspectroscopy using Permount is a viable approach for forensic discrimination of white fibers. For best results, forensic investigators should use as thin a layer of Permount as possible, and routinely take the 365 nm excitation fluorescence spectra of white fibers that show an absorbance peak around 360 nm. Further discrimination may be achieved by extraction of fluorescent brighteners from fibers dyes followed by chromatographic analysis.

Fibers, Fluorescent Brighteners, UV-Vis/Fluorescence Microspectrophotometry

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