B147 A Comparison of Spectra for Common Dyes on Five Different Mounted and Unmounted Textile Fiber Types Using Raman Spectroscopy

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Learning Overview: After attending this presentation, attendees will better understand how Raman spectroscopy can be used to identify dyes on commonly found textiles, what factors may interfere with proper identification, and methods that can be used to mitigate these factors.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a baseline for how Raman spectroscopy may be used in forensic work for the identification of various dye types and colors on several common textiles. As forensic work with fibers often involves mounting single, possibly faded, fibers on slides for ease of examination and long-term storage, this presentation will provide attendees with information on how mounting media and relative dye concentration may affect the results of their analysis. Finally, this presentation will provide examiners with guidelines to help maximize the chances that their analysis may lead to positive identification of fiber dyes with Raman spectroscopy.

Raman spectroscopy is a commonly used technique in forensics that has been successfully employed in the identification of inks, paints, and textile dyes. The objective of this study was to compare the Raman spectra of commonly found textile dyes when dyed on their respective fiber in forensic settings. It was hypothesized that fading dye color and common standard operating practices such as mounting fibers onto glass slides with media may negatively impact the dye signal and investigative results. To test this, the spectra of four common categories of dyes (acid, reactive, disperse, and direct) were analyzed on five different textile fabrics. Each of these fiber types (nylon, wool, cotton, polyester, and viscose rayon), were dyed with four colors: black, blue, red, and yellow. Fibers dyed with blue, red, and yellow were dyed with three concentrations of dye (1%, 0.5%, and 0.05% w/w). Raman spectra were taken for each dyed fiber mounted on glass slides with Permount™ or Entellan® New mounting media, as well as unmounted. Each spectrum was then compared to dye and fiber reference standards to determine the optimal parameters to detect the dye and the relative influence of different mounting media on dye spectra. After taking Raman spectra with two different lasers (532nm and 780nm) on the Thermo Scientific™ Nicolet™ Almega XR, it was determined that successful detection of dye spectra on dyed textiles was predicated on several variables.

Some variables noted to influence the successful detection of dye spectra included dye type, dye color, dye concentration, fiber type, laser source, laser power, microscope objective, the type of mounting media used, and post-measurement spectral processing. For example, it was determined that dye spectra of acid and direct dyes were more defined than spectra of reactive and disperse dyes, and therefore more likely to be detected. Other noted trends included the increased likelihood of the detection of red and yellow dyes over blue and black dyes, and the overlap of some fiber spectra with the spectra of their corresponding dyes, such as nylon and acid dyes. When mounting fibers, choice of mounting media usually did not influence dye detection. However, it was determined that direct blue and red dyes were more easily detected on rayon fibers mounted with Entellan® New than with Permount™. Depending on the fiber and dye, post-sampling processing could sometimes improve dye signal and increase the likelihood of detection, such as in the case of acid dyes when the wool fiber standard and mounting media background signals were subtracted from the spectrum.

To date, there are thousands of known dyes, dye mixtures, and textile blends currently on the market, as well as the different manufacturers of Raman instruments and wavelengths of lasers available. Considering this, it was not possible from the results of this study to make definitive conclusions on recommendations for detecting dye spectra from unknown samples. However, based on the type of fiber being examined and the color of the dye, there are general guidelines presented here that may maximize the likelihood of positive identification, particularly in cases where fibers are mounted onto slides for examination. There is currently a need for further studies utilizing other Raman instrumentation, analysis software, and laser wavelengths to determine the optimal parameters for the detection of dyes on textile fibers.

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