B59 A Characterization of Nylanthrene Dyes in the Differentiation of Macroscopically Similar Black Fibers Using Light Microscopy and Visible Microspectrophotometry (MSP)

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Learning Overview: After attending this presentation, attendees will better understand the unusual nylanthrene dyes used in the coloration of black polyamide fibers and the abilities of the classical analytical methods of light microscopy and visible MSP to characterize and differentiate them.

Impact on the Forensic Science Community: This presentation will impact the forensic science community, and, in particular, trace evidence examiners, by discussing the strengths and limitations of the classical analytical sequence of both microscopy and MSP in the examination of fiber samples that appear macroscopically indistinguishable.

While microscopical and instrumental analysis methods can be used to determine the composition of textile fibers recovered in casework, discrimination in the context of comparative examinations is typically valued by examining the color of a fiber. This is just as important when the bulk composition of a fiber is relatively homogenous, as it is with nylon, acrylic, and other man-made fibers, as it is when the bulk composition of a fiber is heterogenous, as it is with cotton, wool, and other natural fibers. However, these types of analyses often come with more than a few difficulties, including very small sample sizes, the need for non-destructive techniques, and the enormous complexity of both archaic and modern dye compositions. Fiber examinations start by means of light microscopy methods. The determination of whether the fibers are natural (e.g., cotton or wool) or man-made (e.g., viscose, polyester, acrylics, or nylons) is initially made. Man-made fibers usually display a large number of morphological features (i.e., width, cross-sectional shape, presence of delusterant particles, or particular surface striations). Polarized light microscopy is used to study optical properties of man-made fibers. Color, dichroism, and fluorescence are important features used during comparative examinations. It is then suggested that either visible MSP followed by Thin Layer Chromatography (TLC) be used if Ultraviolet/Visible (UV/Vis) MSP is not available. While MSP is concerned with the measurement of the color of fiber specimens, typically resulting from dye mixtures, TLC procedures offer the potential to determine the dye class and the number of components of a given mixture. However, what about fiber samples that macroscopically appear identical after examination using tried-and-true methods?

In this project, a reference collection containing 14 black swatches on a shade card was dyed with known concentrations of four known nylanthrene dyes: nylanthrene black GLWC, nylanthrene rubine SBLF, nylanthrene navy LFWG, and nylanthrene orange SLF. These understudied nylanthrene dyes are no longer being used and have since been discontinued, but they are still susceptible to being recovered in casework at the present time. These dyes were typically used for the dyeing of polyamide 6 or 66 and were known for their favorable migration properties, which provided both excellent coverage as well as stain resistance. These fabric swatches appeared macroscopically similar to each other, and each fabric swatch was dyed with either one, two, or three of the four potential dyes with a total dye concentration of 4% in each swatch. Several fibers were isolated from each swatch and characterized microscopically using bright field illumination and Polarizing Light Microscopy (PLM). Cross-comparisons were carried out using the analytical sequence of comparison microscopy and visible MSP. Pairwise comparisons were performed in which a value of one, two, or three was assigned to each compared pair, based on the difficulty of differentiation, with a value of three assigned to those pairs that were easily differentiated, and a value of one assigned to those pairs that were not able to be differentiated. Out of 91 pairs of fibers, 90% or 82 of the pairs could be differentiated. However, 10% or nine pairs could not be differentiated using either comparison microscopy and/or MSP. Of the nine pairs that could not be differentiated, almost half, (44% or four pairs) differed in their concentrations of only navy and black dye concentrations, while 22% or two pairs differed in their concentrations of only black and orange dye concentrations. The remaining 34% or three pairs differed in their concentrations of orange and navy, in their concentrations of black, navy, and orange, and in their concentrations of black, navy, and rubine.

Trace Evidence, Microscopy, Microspectrophotometry

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