B166 The Effect of Ultraviolet Radiation on the Microspectrophotometry (MSP) of Dyed Textile Fibers: Spectral Alteration Categories

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Learning Overview: After attending this presentation, attendees will understand about the alterations in spectra collected using ultraviolet/visible (UV-Vis) microspectrophotometry (MSP) that can occur when dyed fibers are exposed to ultraviolet (UV) radiation at different time intervals.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing information useful to the interpretation of microspectrophotometry (MSP) data in typical casework when unknown fiber specimens and reference fiber samples are collected at different times.

MSP is the method of choice for the comparative examination of dyed textile fibers. Ordinarily, fiber specimens of unknown origin (e.g., fibers from clothing recovered at crime scenes) are compared using the same conditions as reference samples from a suspected source. However, in some instances, reference fibers may be collected at a time shortly, or long, after the recovery of the unknowns. During this lapse of time, one or both sets may undergo fiber dye degradation due to weathering (e.g., exposure to natural sunlight).

In this project, MSP spectral alterations are being studied using a reference collection of 53 different swatches consisting of man-made commercial and man-made custom-dyed fibers. Swatches are being exposed to natural sunlight in Arizona and UV radiation in a light box in the laboratory at McCrone Research Institute in Chicago for what will be a total duration of 18 months. MSP is proposed to measure the effect of ultraviolet radiation on color from a variety of fiber and dye types. Samples include common fiber types, such as polyester, nylon, and acrylic, with different color dyes typical for each fiber type. The current phase of this study (July 2018) focuses on the types of spectral alterations that can occur when dyed fibers have been exposed to UV radiation for 8, 16, and 24 weeks.

Because MSP also uses visible and UV radiation, a separate study of instrument-induced photobleaching of 60 minutes, with spectra collected every 60 seconds, was also carried out for each sample to study any degradation in the collected spectra that may occur during routine MSP analysis. The goal was to detect sets of spectra for a given week (8^{th}, 16^{th}, 24^{th}) that do not fit in the range of variation of the spectra collected without previous UV exposure (T0). The first spectral deviations from the range of variation of spectra collected at T0 and the type of initial spectral alterations were recorded; photomicrographs were collected during analyses to compare visual fiber dye-color fading and spectral deviations for a given time. After MSP instrument-induced photobleaching, it was noted that all except one sample exhibited spectral deviations. Two samples could not be assessed due to their large intra-source spectral variation. The results show that different times of occurrence for the onset of spectral alterations were measured for the different samples. These spectral alterations were observed either in the visible range only, in the short UV range only, or in both the visible and UV spectral ranges. Spectral alterations were observed and grouped into six different categories: out-of-range (20 samples), band shifts (10 samples), band flattening (six samples), bump formation (five samples), bands fusion (one sample), and combinations of these (eight samples).

From the reference collection of 53 samples, for fifteen of them no spectral differences were observed between MSP captured at T0 and subsequent weeks up to 24 weeks. However, spectral alterations were observed for 32 samples. Twenty samples exhibited differences in spectra collected at zero and eight weeks of UV exposure. Spectral alterations were first noticed after 16 weeks for seven samples. Spectral changes were observed for five samples after a UV exposure of 24 weeks. It was not possible to determine the occurrence of spectral alterations for six samples due to the high intra-source variation of spectra collected after various weeks.

Finally, with very few exceptions and from the photomicrographs collected in conjunction with MSP analysis, photobleaching of the fibers was not visible together with the observed spectral alterations, indicating that spectral alterations generally precede visually detectable photobleaching. This is not in agreement with the simple observation of the textile fiber swatches that appear noticeably bleached after weeks of UV exposure.

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Trace Evidence, Fiber, Microspectrophotometry