B77 Multivariate Statistical Approaches for the Discrimination of Textile Fibers by UV/Visible and Fluorescence Microspectrophotometry

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After attending this presentation, attendees will be briefed on the use of multivariate statistics applied to a validated UV-visible and fluorescence database to visualize differences between groups of fiber spectra, to confirm the statistical validity of that discrimination, and to assess the match of questioned fibers with pristine-condition "known" fibers pre- sumed from the same source.

This presentation will impact the forensic community and/or humanity by demonstrating how fibers and associated spectra in the database, in combination with validated computer programs, represent an extensible tool for fiber comparisons in casework and should also be of value in quality control and training of analysts.

Trace evidence has taken on a role of increasing importance in forensic investigations. The principle that "every contact leaves a trace" establishes the potential value of minute traces of evidence found at the crime scene, or found on a victim or suspect. Fiber evidence is class evi- dence (*i.e.*, not unique), because many fibers from different sources could be indistinguishable. The discovery of a fiber and its identification as a par- ticular fiber type (*e.g.*, acrylic, cotton, nylon, polyester) may not, of itself, provide much support for a forensic investigation. The probative value of particular fibers found at a crime scene depends on their uniqueness relative to the background of fibers normally encountered at that location in the absence of the crime. What is often required is information that makes the trace evidence more specific and discriminating.

Ultraviolet-visible (UV-visible) and fluorescence microspectropho- tometry of mounted fibers offer direct, relatively inexpensive, and infor- mative means of characterizing dyed and finished fibers. These studies were initiated to improve the forensic discrimination of fibers by providing both protocols for the most discriminating analytical approaches and vali- dated data analysis methods. In support of these goals, the authors have developed a database of over 1,500 dyed textile fibers collected from com- mercial sources. Over 25,000 spectra, consisting of UV-visible absorbance spectra and fluorescence spectra taken at four excitation wavelengths (365, 405, 436, and 546 nm), were also acquired. The database was recently extended to include spectra from a variety of single-color and tri-color fibers that have been exposed, using systematic designed experiments, to different environmental weathering conditions, including detergent washing and natural weathering.

Principal component analysis (PCA) and linear discriminant analysis (LDA) produce visually interpretable maps of spectral similarity. Both UV- visible and fluorescence spectra provide discriminating information, depending on the particular dyed textile fibers under comparisons. UV- visible microspectrophotometry, by itself, is most discriminating. The dis- criminating power of fluorescence MSP approaches that of UV-visible MSP, and appears to add considerable discrimination beyond that provided by absorbance measurements. For colored fibers, the higher excitation wavelengths (405, 436, 546 nm) provide the best discriminating power. Additional discriminating power can be achieved by using combined UV- visible and fluorescence data in fiber comparisons.

Besides facilitating rapid identification of outliers in spectral data sets, PCA and LDA are of great utility in visualizing differences between groups of spectra, and in confirming the statistical validity of discrimination using appropriate statistical hypothesis tests. Changes in UV-visible and fluores- cence spectra as samples are exposed to environmental weathering can also be tracked. For example, after detergent washing of cotton and nylon fiber samples, changes in fluorescence due to the presence of fluorescent bright- eners in detergents can increase discrimination. Multivariate statistics can also provide rapid comparison of spectral differences. The fiber examiner may then be able to correlate spectral differences with known photodegra- dation processes in dyes and other physical changes in fibers that result from the specific environmental exposure. Another focus area involves assessing the ability to match weathered fibers with pristine-condition "known" fibers from the same source.

The fibers and associated spectra in the database, in combination with validated computer programs, represent an extensible tool for fiber com- parisons in casework and should also be of value in quality control and training of analysts.

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Fiber Examination, Microspectrophotometry, Statistical Analysis

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