B91 Comprehensive Fiber Analysis and Classification

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The goal of this presentation is to introduce polarized light microscopy, along with, IR, and Raman spectroscopy as methods to characterize and quantify weathering effects of fabrics and fibers.

With a database of chemical composition characteristics compiled from research with PLM, FTIR, and Raman, fibers could be more readily differentiated and characterized according to age and weather. This presentation will impact the forensic community and/or humanity by giving the forensic community an opportunity to utilize fiber evidence more so than in the past. Since fibers are prevalent among crime scenes, this new database would give new insight into a fiber's origin. With more research, fibers could be chemically characterized where two identical fibers could be differentiated. With more research, fibers would have more evidentiary value and would finally be pivotal evidence in forensic cases.

Novel methods for analyzing the chemical characteristics of fibers must meet certain criteria in order to be acceptable in the forensic laboratories. Methodologies must employ readily available instrumentation, be rapid and non-destructive, and require minimal sample preparation. With those goals in mind, primary methods for identification being researched are bright-field/polarized light microscopy, FTIR microscopy, and Raman spectroscopy.

Many studies have been done on the chemical characterization of fibers, but few have gone beyond the realm of chemical differences in manufacturing. Very few studies have conducted any testing on fibers that have been aged or have looked at the differences in chemical composition over time. It is the goal of this work to:

1. Determine which chemical characteristics of fibers are attributed to manufacture.
2. Determine which chemical characteristics are attributed to weather.
3. Determine if chemical characteristics caused by weather can be useful in discriminating between otherwise identical fibers.

Fibers in this study were analyzed using a combination of PLM, FTIR, and Raman microspectroscopy over a time period during which they were subjected to simulated weathering conditions and the chemical changes were tracked. Four types of fibers were tested; cotton, nylon, polyester, and rayon. These fibers were dyed four different sets of colors in three different shades. Each fiber has a light, medium, and dark swatch of red, yellow, blue, and green, as well as unprocessed uncolored fibers. For the PLM experiments, fibers were cut into inch by inch squares and arranged in plastic pallets with small holes to access the fibers. One pallet was exposed to UV light and the other was washed repeatedly. For the PLM, LAB coordinates were taken to track the color changes over time as the fibers were artificially weathered. Using chemometrics, color degradation could be graphed over time for both pallets. For the FTIR, fiber swatches approximately inch by inch were taped to the shiny side of aluminum foil wrapped around glass slides. IR spectra were taken of each make and color of fiber before and after successive UV exposures. For the Raman, fiber swatches were again taped to the shiny side of aluminum and spectra were taken before and after successive UV exposures.

This comprehensive study has proven successful in identifying discernible chemical changes occurring over time due to the simulated weathering of fibers through UV exposure and washing. Chemometric analyses have shown a decrease in color as the fibers have been aged through PLM. IR spectra show noticeable differences between exposures. It is the hope of this work that the data would be organized into a database where a questionable fiber's chemical characteristics could be plotted and compared to standards. Chemical characteristics could indicate the age or degree of weathering, such as to discern between a brand new and an older fiber.

IR, Raman, Fibers

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