B160 Probing the Effects of Inherent Variability in Forensic Fiber Analysis

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After attending this presentation, attendees will better understand the various sources of variability inherent in forensic fiber analysis, which stem from both the sample itself and the methodology used.

This presentation will impact the forensic science community by increasing awareness of this variability and providing some suggestions as to how analysts might reduce this variability in their measurements. An eventual impact of this study will be the creation of a reference database that can be used by fiber examiners to compare their results and techniques to a standard set of known data.

In this experiment, a reference collection of synthetic fibers was used to investigate the effects of polymer type, starting diameter, shape, and compression on the resulting Fourier Transform Infrared (FTIR) spectra. Using a randomized experimental design, reference fibers were embedded in polyethylene and hand-sectioned to determine cross-sectional shapes and diameters via Scanning Electron Microscopy (SEM). A separate randomized experimental design was created to test two different known torques (5N·m and 7 N·m) to flatten these fibers in a diamond compression cell. A torque wrench with a 3D printed adapter was used to help standardize compression, and the resulting thickness of the fiber films was measured for uniformity with an optical profilometer. The starting versus ending thickness information was compiled and compared with the polymer material and shape to define any trends, note inconsistencies, and identify places for improvement. A similar action plan was taken to measure FTIR spectra before and after compression, and the spectral features were compared to see if any optimization in the process could be obtained.

SEM analysis verified that even along a single fiber there existed measurable variation in starting diameter, and the profilometer measurements showed that cross-sectional shape and different torque strengths influenced the fiber film thickness. Large relative standard deviations in the measurements resulted from different areas of the film being measured; for example, trilobal fibers, such as nylon, produced widely different thicknesses after compression, depending on the orientation of the fiber when it was placed in the diamond cell.

This study takes the first steps in understanding how differences in fiber type, fiber shape, and methodology affect the outcome of fiber analysis, with concerted effort placed on characterizing that variability. Primarily, this research seeks to raise awareness of the variability that accompanies the analysis process by evaluating and refining analytical techniques commonly used by forensic examiners. The end goal is to establish a database based on the Microtrace fiber reference collection of chemical spectra that combines microscopic measurements of fiber cross-section and diameter with FTIR spectra, and eventually add Microspectrophotometry (MSP) and Raman, where appropriate.

Fibers, Reference Database, Trace Analysis

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