B150 An Improved Method for the Analysis of Fiber Evidence Using Polarized Light Microscopy (PLM)

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After attending this presentation, attendees will better understand a unique, useful, and rapid method using a traditional PLM to classify and identify the composition of fiber evidence.

This presentation will impact the forensic science community by introducing a new approach based on mounting fibers in a fluid medium that has a Refractive Index (RI) value that is intermediate between the fiber's principal RIs. When fibers are mounted in such a fluid medium and observed with a microscope equipped with a single linear polarizer, the fiber's RI will match the mounting fluid's RI at some specific angle of rotation. This angle of match is easily measured and provides a quantitative value for classification.

Multiple fiber types may be present in a single mount and be classified individually without the need to prepare multiple mounts. Implementing this method requires a polarized light microscope with a graduated rotating stage and is most efficient when either a graduated rotating polarizer or analyzer is available.

The classic PLM method of fiber identification is to measure the principal refractive indices using the Becke line method to determine the relative RI between the fiber and its surrounding mounting fluid.[1] The classic method requires mounting of fibers in a series of fluids of differing RIs until both principal RIs are matched. Synthetic fibers and some natural fibers behave optically as uniaxial crystals. As such, fibers have a continuous gradient of refractive index. This gradient ranges from the high to low values of the principal RI. Fibers have their principal RI values aligned parallel and perpendicular to the fiber axis. In this method, a fiber is mounted in a fluid with an RI value that is between the two principal RI values. It is observed using only linear polarized light. As the orientation of the polarized light vector is changed relative to the fiber axis, the Becke line will vanish. The angle between the fiber axis and the position at which the Becke line is indistinct is readily measured using a PLM. The PLM must have a rotating stage and either a graduated rotational analyzer or substage polarizer. A rotating stage is used to align the fiber so that the initial polarization direction is parallel to the fiber axis, then the analyzer (or polarizer) is rotated until a match point is reached. This angle of matching RI is only a function of the fiber composition and refractive index of the fluid.

The angle of rotation for matching refractive index (θ) can be calculated when the refractive index of the mounting media and the principal values of the fiber are known. Using the equation of an ellipse in spherical coordinates, a spread sheet was developed to generate tables of data that aid in textile fiber analysis. For example, fibers mounted in refractive index fluid RI=1.570 have angles of matching refractive index (θ) as follows: nylon (vivrelle), 0.0°; olefin (PE), Q=22.4°; nylon 6, Q=19.4°; nylon 6, 6 Q=24.5°; polyester (PCDT) Q=55.8°; polyester (PET) Q=65.7°; polyester (PTT) Q=75.2°. These data demonstrate the ability of this method to identify several common fibers in a single preparation. The efficiency of fiber identification is greatly improved over the classical PLM method.

Reference(s):

1. Gaudette, B. The forensic aspects of textile fiber examination, In Saferstein R. editor. *Forensic Science Handbook, Vol II.* Englewood Cliffs, NJ 1988, 255-261.

Fiber, Evidence, PLM