A136 Micro-Raman Mapping of Dissimilar Inks on Paper

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After attending this presentation, attendees will be presented with an example of identifying the order of ink deposition where lines cross by micro-Raman mapping using two types of maps, surface, and depth slice, providing a visual interpretation of the analytical data that is easy for juries to understand.

This presentation will impact the forensic science community by demonstrating the use of micro-Raman mapping as a visual technique well suited for courtroom presentations.

When documents are altered, the order of ink layer deposition where lines cross is an important determination confronting questioned document examiners. Knowledge of the top layer suggests the intent of the alternation and knowledge of the lower layer provides information about the document's original content. Together, this information helps establish motive, may suggest a suspect, and establishes a timeline of the crime.

Conventional ballpoint pens were tested by making a figure of a cross with single lines of different inks. Reference spectra were acquired at various locations on the inked legs of the cross where lines of individual inks existed, and for paper at adjacent locations near the inked lines. At the microscopic level, paper composition is inconsistent and ink coverage is inconsistent and incomplete. These difficulties were overcome by averaging several repeated scans at every test location to assure instrument accuracy, followed by averaging all scans of each individual ink and paper to compile representative standard spectra of each component. The same sampling scheme was used in the area where lines crossed.

Micro-Raman analysis does not destroy the sample. Confocal optical design limits the depth of focus to very thin layers, allowing small volumes to be analyzed without interference from the surroundings. Raman excitation was 785nm and spectral response was measured from 850cm^{-1} to 3200cm^{-1} or from 1250cm^{-1} to 1750cm^{-1}. Other instrument settings were 30 second exposure time, 10% laser power, and two accumulations at either 20x or 50x magnification at high confocality.

Maps are like digital photographic images composed of cells (pixels) that hold both the Raman spectrum and photographic information at that location. Steps between cells can progress at 1.0 micrometer increments in either the x or y horizontal directions to produce two-dimensional (2D or x,y) surface maps; or vertically (y direction), to produce depth slice maps that appear as vertical cross sections above and/or below the paper surface.

To show ink locations on the mapped surface, standard reference spectra of paper and each ink were assigned a false color and matched to the spectra in each mapped cell. The location of each component was visualized by redrawing the map with the assigned false colors.

False colored maps require little technical explanation and are easily understood, allowing juries to draw their own conclusions. This frees the expert of the need to express his own conclusion that judges sometimes disallow because it is held to be "subjective."

Micro-Raman Mapping, Ink Analysis, Document Alternation

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