J1 The Use of Microscopy-FTIR-ATR Technique to Determine the Sequence of Crossed Lines

Tamas Gal, Agnes Karoly, and Judit Sandor, MSc, Institute for Forensic Sciences, 1903 Budapest, PO Box 314/4, Budapest, HUNGARY*

After attending this presentation, attendees will be briefed on a Microscopy-FTIR-ATR method for the determination of the sequence of crossed lines.

This presentation will impact the forensic science community by providing a efficient method for the determination of the sequence of crossed lines.

The determination of the chronological sequence of crossed lines has been a difficult problem in document examination. The similarity of physical and chemical properties of printer toners and pen inks make the work of forensic experts more difficult, because only determinations of minor differences can lead to an identification. In relation to ransoming, anonymous or threatening letters, discrimination and identification of printers or pens is often required. In cases of fraud, it must be determined whether the document has been additionally altered. In the case of counterfeit documents, one needs to determine the sequence of crossed printer and pen ink lines to answer the very frequent question, was “signature or printed text first on the document?” Up until now, solution to these problems required experts to run time demanding investigations and the results were more or less subjective. Microscopy- based infrared ATR technique as opposed to optical microscopy techniques is a simple, fast, non-destructive method, which does not require sample preparation and provide an objective result, while also leaving the documents intact.

In this experiment, spectra were collected using a Bruker Vertex 70 infrared spectrometer equipped with a 20x ATR objective Bruker Hyperion microscope. Before the analysis the measurement spot on the document is defined, while the ATR objective has to be made in the visual mode. During the examination the documents contact with the surface of the Ge crystal at 100 mm diameter. Through principle of measurement, infrared spectral information is gathered from ~1 mm depth layer of the surface. In connection to questionable documents, the most common and indistinguishable samples are the black printed and black handwriting lines. In our experiment we investigated black toners of laser printers and black pen inks because examination of these samples by other optical analytical methods has serious difficulties.

Polymer resin, the main component in dry black printer toners, creates a millimeter thin, black surface layer on the paper. Printed matter can be investigated in situ by its infrared spectrum without any disturbing effect, because the penetration depth of the infrared radiation is smaller than the thickness of the printed layer. The liquid pen inks penetrate into the micro fibers of the paper, so much so that, the upper sides of the cellulose fibers are saturated entirely with pen ink. Because of this fact the disturbing effect of cellulose fibers of paper cannot be removed from the spectrum. For determination of the sequence of crossed lines, the exact definition of line crossing points of document is provided (when ATR objective works in the visual mode), so the chemical composition of the surface layer can also be examined at this point based on the spectrum. By analyzing the upper layer, the sequence of crossed lines of printer toner and pen ink is determined.

The microscopy FTIR-ATR method is a very suitable technique for the examination of printed and handwritten documents. Using this technique different types of printer toners and pen inks can be distinguished by their chemical fingerprints. The sequence of crossed lines can be determined by measuring the surface layer at the line crossing point. Additionally, the measurement neither destructs the document nor does it require sample preparation. This analytical method is objective and easy to interpret. Application of the method makes an easier comparison of questioned documents for forensic experts in criminal cases.

Document, Crossing-Lines, FTIR

 ** Presenting Author*