J18 Examination of Line Crossings by Infrared Chemical Imaging

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Attendees will gain an understanding of the application of infrared chemical imaging in determining the sequence of intersecting lines on questioned documents.

With technology continuously evolving, this presentation will impact the forensic community and/or humanity by exploring new developments that may prove to be superior to techniques currently in use in forensic laboratories. Infrared Chemical Imaging has been demonstrated to be effective for the examination of intersecting lines on questioned documents.

This poster focuses on a preliminary examination of infrared imaging as an objective, non-destructive technique for examining line crossings.

Determining the sequence of intersecting lines is still a problem faced by forensic document examiners. Many of the techniques used are either subjective in nature, or are partially destructive. FTIR spectroscopy, using an ATR accessory, is a non-destructive method that can be used to analyse ink and toner in situ on documents. However, until recently, FTIR spectroscopy has been limited to single-point analysis only.

Recent advancements in technology have led to the development of FTIR imaging, a powerful new technique, which is capable of simultaneously obtaining both spectral and spatial information. FTIR imaging uses a Focal Plane Array (FPA) detector, which can be thought of as 64 x 64 discrete detectors (or pixels) laid out in a grid pattern. This detector simultaneously collects 4096 spectra in a single image with a spatial resolution of approximately 5 - 10 microns using the microscope or around 50 microns using the Large Sampling Accessory. In the latter case (used in this study), the image size is approximately 3 x 3 mm.

The advantages of infrared chemical imaging include its ability to provide both spatial and spectral information. In approximately the same amount of time taken by a conventional spectrometer to collect a single spectrum, this new technology can simultaneously collect thousands of spectra using an array detector and thus map the spatial distribution of chemical species across a sample. The ability to image ink and toner in situ, without the need to remove the material by a destructive means such as lifting and cutting, means that the technique is suitable for the nondestructive analysis of the sequence of intersecting lines. An important advantage of infrared imaging over visible light chemical imaging is the greater number of spectral bands that can be used to characterize or identify a given molecule. Another advantage is that it produces visually appealing displays that can be useful in demonstrating results to the layperson, such as a jury member.

Currently there is an extremely limited amount of research published on forensic applications of FTIR imaging. Therefore the benefits provided by FTIR imaging have yet to be fully explored, and it holds enormous potential for forensic analysis. FTIR imaging may have numerous applications in questioned document examination. This poster focuses primarily on the study of infrared imaging as a technique to determine the sequence of intersecting lines. For this preliminary examination, intersecting line samples that were prepared using a wide range of writing media were studied in order to determine the capability of the technique. Writing materials examined included various pens (including ballpoint and gel pens), and laser and ink-jet printing. Samples were prepared using a range of pressures, from light to heavy, and also over varying time intervals. Samples were imaged using the Digilab Stingray IR imaging system with zinc selenide and germanium FastIR ATR accessories (Harrick Scientific).

Preliminary results demonstrated that infrared chemical imaging was able to successfully image toner and ballpoint ink in situ. By imaging on an infrared band (peak) present in only the toner or ink spectrum, chemical images showing the spatial distribution of these materials could be obtained. Using the ink chemical images, it was possible to determine the sequence of intersecting lines. To test the validity of the technique, blind testing was conducted. Results demonstrating the advantages and disadvantages of infrared imaging as a technique for examining intersecting lines will be presented.

Questioned Documents, Line Crossings, Infrared Chemical Imaging

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