B29 The Detection and Enhancement of Latent Fingermarks Using Infrared Chemical Imaging

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After attending this presentation, attendees will gain knowledge of the capabilities of a novel technique (infrared chemical imaging) for imaging latent fingermarks on difficult surfaces.

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 detecting fingermarks on difficult substrates.

This poster will present the results of a study that began in 2003 and continues to date. During this study the use of a new technique, Fourier transform infrared (FTIR) chemical imaging, has been demonstrated for the enhancement of latent fingermarks on a number of surfaces.

All fingerprint detection techniques aim to create contrast between the ridge details of a latent fingermark and the background on which it is located. The majority of current methods rely on this contrast to be in the visible part of the electromagnetic spectrum, and thus encounter problems when background interferences such as printed images or patterns are present. Some of these problems may be overcome using traditional visible or fluorescence imaging techniques (e.g., alternate forensic light sources with appropriate barrier filters) or visible and fluorescence chemical (hyperspectral) imaging techniques. However, due to the very broad, overlapping bands that make up all visible absorbance and fluorescence spectra, it is not always possible to obtain acceptable fingerprint images even using chemical imaging techniques in this region of the electromagnetic spectrum.

The vibrational spectra (infrared or Raman) of most carbon compounds consist of large numbers (often more than ten) narrow, wellresolved bands that represent vibrational modes of discrete functional groups in these molecules. As a means of identifying and discriminating between different molecules, vibrational spectra are thus far more powerful than UV-visible methods, which consist of very broad, overlapping bands. To date, this inherent feature of infrared (and Raman) spectra has not been utilized in the forensic visualization of fingermarks. This is because that, until recently, infrared and Raman techniques provided no spatial information on a sample. Spatially resolved chemical information, however, is now accessible with the development of infrared chemical imaging.

FTIR chemical imaging employs a focal plane array (FPA) detector that can be thought of as a large number (thousands) of discrete detectors (or pixels) laid out in a grid pattern (Digilab, Nicolet, Bruker instruments). The instrument collects images that may consist of thousands of pixels, with a spectrum at each pixel. In this way thousands of mid-infrared spectra are simultaneously collected from a sample while maintaining spatial information.

By far the most common type of FPA detector used for mid-infrared chemical imaging is a 64 × 64 pixel mercury cadmium telluride (MCT) focal-plane array detector. The detector used in this study was a Digilab Lancer 64 x 64 MCT detector. This detector collects 4096 infrared spectra simultaneously into a file that can be thought of as a datacube. This three dimensional datacube (x x y x wavenumber) can be visualized as a collection of images of the sample, with one image for each wavenumber resolution unit.

This poster describes the application of infrared chemical imaging to the visualization of fingermarks, with and without cyanoacrylate fuming, and explores the future possibilities of this technique. Images of untreated fingermarks on glass substrates with excellent ridge detail were acquired using infrared chemical imaging. High quality fingermarks on glass substrates were also developed using ethyl cyanoacrylate (super glue) fuming and subsequent infrared chemical imaging. This new method allows the collection of images from backgrounds that traditionally pose problems for current fingerprint detection methods. The background may, for example, be highly colored, have a complex pattern, or possess other pattern or image characteristics that make it difficult to separate fingerprint ridges using traditional optical or luminescent visualization. One background that has proven to be a challenging surface for the development of latent fingermarks is the Australian polymer banknote. To demonstrate the power and applicability of infrared chemical imaging, latent fingermarks fumed with ethyl cyanoacrylate were successfully imaged from Australian polymer banknotes.

This imaging technique has shown enormous potential for the detection and enhancement of latent fingermarks on a range of surfaces. This work is currently being extended so that the true capabilities of infrared chemical imaging may be realized. It is important to stress that this new method does not aim to replace any of the currently used fingerprint enhancement techniques, but rather aims to provide the forensic scientist with a tool that may prove useful on surfaces where conventional techniques fall short.

Infrared Chemical Imaging, Latent Fingermarks, Hyperspectral Imaging