B148 Applications of Visible and Near Infrared Chemical Imaging to the Analysis of Forensic Evidence

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Attendees will gain an understanding of chemical imaging and the general application of this new technology in the field of forensic science.

With technology continuously evolving, it is important to explore new developments that may prove to be superior to techniques currently in use in forensic laboratories. This presentation will impact the forensic community and/or humanity by demonstrating how chemical imaging offers a higher discriminating power and greater sensitivity compared to conventional digital imaging.

This oral presentation will describe the theory of chemical imaging and demonstrate how this emerging technology has enormous potential in the forensic analysis of materials when compared to traditional digital imaging techniques.

Chemical imaging combines molecular spectroscopy and digital imaging, providing both spatial and spectral information of materials. Light intensity is detected as a function of wavelength as in spectroscopy, and is also detected as a function of location as in conventional imaging to form a data set. The three-dimensional data set has a fully resolved image at each individual wavelength and a full spectrum at each individual pixel. Valuable information can then be extracted from the large data sets through the utilization of specialized software designed for chemometric and image analysis. Common processing tools include zero offset, normalization and principal components analysis.

This promising technology has a wide variety of applications in many scientific and industrial fields, one of which is in forensic science. Chemical imaging offers many advantages for forensic science applications. Over a short analysis time, information on morphology, composition, structure and concentration can be obtained and displayed side-byside. It is also a non-destructive technique that utilizes well-accepted microscopy and spectroscopy methods, with little or no sample preparation required.

The liquid crystal tunable filter (LCTF), the basis of the chemical imaging instruments considered here, is extremely advantageous as it replaces the often numerous detection filters needed. The LCTF is able to perform analysis with less than 1 nm increments, which greatly increases the sensitivity capabilities of the analysis. The VIS/NIR ChemImage 'Condor' Macroscopic Chemical Imaging system, as used in this research, consists of an electro-optical tunable filter system with a charged couple device (CCD) camera on a macroscopic platform. The total spectral range of the VIS/NIR Condor is from 400 nm to 1100 nm.

This research project is focused on establishing the potential for the use of the VIS/NIR Condor for forensic evidence analysis with special focus on the analysis of inks on questioned documents. Over 110 pens have been sampled (specifically blue and black ballpoint and roller-ball pens). Chemical imaging analysis using the VIS/NIR Condor was conducted on inks deposited on white paper. Resulting data sets were then processed using the software to distinguish between the different inks. Traditional optical techniques currently in use for ink analysis were used to obtain comparison data.

Other avenues of research include firearm propellant analysis, latent fingerprint detection, and textile fiber comparison. Unfired and fired firearm propellant was examined using the VIS/NIR Condor with the objective of determining if fluorescence can be used for the detection and identification of propellant grains. Latent fingerprints on porous and nonporous surfaces were examined before and after common reagent treatment to establish if additional ridge detail could be detected using the chemical imaging system. Red and black textile fibers were examined in transmittance, reflectance and fluorescence mode to ascertain if Chemical Imaging produced superior discriminating powers compared to traditional techniques.

All evidence types examined produced extremely promising results. The chemical imaging technology was able to distinguish a greater number of inks and fibers. Propellant grains on a target could be traced to the brand that was used in the shooting. The VIS/NIR Condor proved to be an advantage when examining latent fingerprints, especially weak marks or marks on surfaces that produce highly luminescent backgrounds. Untreated latent fingermark ridge detail could also be detected in some cases.

This is an ongoing research project that will be expanded to include a range of evidence categories to fully validate the technology. Initial results show that chemical imaging has great potential in the analysis of forensic evidence including questioned documents, firearm propellants, fingerprint detection and textile fibers.

Chemical Imaging, Ink Analysis, Trace Evidence

 ** Presenting Author*