A176 Imaging Using Synchrotron Radiation: A New Tool for Forensic Science

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After attending this presentation, attendees will learn a different approach to latent fingerprint development which allows determining complete friction ridge details and important additional information regarding origin, chemical composition, and potential contaminants of the finger deposit, facilitating subsequent DNA analysis.

This presentation will impact the forensic science community by providing a new powerful tool for personal identification in high profile cases by means of Synchrotron Radiation facilities, particularly useful in the analysis of IED fragments.

Forensic science has experienced an increasing interest in research activities: all paths that allow the investigators to obtain more information about major crimes are tracked to solve offenses related to national security like terrorists attacks. The goal of the research, established in the framework of a project funded by the Italian Interior Ministry, by “Fondo Trieste” fund, is to adopt a multi-technique approach based on conventional and Synchrotron Radiation (SR) techniques, and to study latent fingerprints from the morphological and chemical point of view. The main goal of the research is to perform fingerprint analysis by its visualization with a SR source. The ultimate objective is to develop methods of image reconstruction that merge all the information coming from different SR techniques to produce valuable evidence gathered with additional information regarding the chemical nature and the contaminants of the enhanced fingerprint.

The analysis is performed using infrared micro spectroscopy (IRMS) on sweat fingerprints, by X-ray phase contrast (XPC), and by X-ray absorption fine structure analysis (XAFS) on contaminated ones.

Multiple donors, both male and female, were chosen to deposit the fingerprints. Prior to the deposition, each donor behaved normally and hands were not cleaned. Moreover, latent prints were not charged by inducting artificially sweat in any way. Each deposition was performed as a depletion series of eight fingerprints by the same finger, to take into account components abundance and to model, if possible, the real situation. The substrates chosen were silicon wafers and PET sheets. Contaminated fingerprints were realized shooting with a gun, prior to deposit, with the depletion technique.

With the intent to characterize the chemical nature of the fingerprint deposit and to make a chemical imaging of it, IRMS was used. It resembles hyper spectral imaging: the fingerprint sample of interest is analyzed (either in parallel or serially) with a broad spectrum IR light source, ranging from 4000 cm^{-1} to 500 cm^{-1} (Mid IR region). Then, spectra are collected by a single-element detector. Each picture element is not characterized by a unique intensity value, but by a full spectrum in the same band
mentioned above.

The broad methyl and methylene stretch bands (from 3000 cm^{-1} to 2800 cm^{-1}) can be found in all donors spectra. In the 1800 cm^{-1} to 1400 cm^{-1} range some donors show an intense carboxylate band signal around 1590 cm^{-1}, while others are characterized by the amide I (around 1650 cm^{-1}) and amide II (around 1540 cm^{-1}) stretching bands. Each donor shows different spectral shapes, with different relative intensities in the same bands, due to the different proportions of the fingerprint components. The ability to solve the amide I and amide II contributions in the 1800–1400 cm^{-1} band, decoupling those from the intense carboxylate signal around 1590 cm^{-1}, will allow the analysis of the fingerprint.

With the goal to characterize the contaminated fingerprints on silicon, XPC technique was used. This technique exploits the phase difference caused by the sample in the X-ray’s path from the source to the acquiring sensor. The energy values chosen ranged from 8 keV to 35 keV. The analysis made on contaminated fingerprints with the XAFS technique showed the presence of metals, thus several images were taken with XPC just above or below the absorption of these elements. In practice, suitable preprocessing algorithm will have to be used to improve the signal-to-noise ratio which is very low due to the small quantities of contaminants and, consequently, to their low absorptions.

While being in its early stage, the research seems promising in visualizing latent fingerprints. Moreover, the added value of giving a complete morphological and chemical characterization of the fingerprint and its contaminants could enrich the classical approach with key additional information, facilitating also subsequent DNA analysis so as to identify the perpetrator.

Synchrotron Radiation, Trace Analysis, Latent Fingerprints

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