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Exploring the Spatial Distribution of Chemical Species within Latent Fingermarks using Infrared Microscopy

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The successful recovery of latent fingermarks is a valuable tool in crime scene investigations to establish connections between suspects, objects and locations. The chemical composition of fingermark residue is a complex mixture of aqueous (eccrine fraction) and lipid (sebaceous fraction) secretions with contaminants such as food and cosmetic residues. By visualising the relative abundance and distribution of chemical components within fingermark residue we can provide explanations for the variation in reproducibility of latent fingermark detection with existing methods, and to identify new strategies to increase detection capabilities.

Infrared (IR) spectroscopy has been used to study fingermarks in situ to investigate aging, donor variation and chemical changes in fingermark residue over time. Despite the relative improvement of spatial resolution obtained with FTIR compared to other methods (e.g. imaging mass spectrometry), the spatial resolution is still hampered by the long wavelengths of light used relative to optical microscopy, as well as the limitation of substrates when working with transmission FTIR. One alternative is to use attenuated total reflectance FTIR (ATR-FTIR), which improves spatial resolution and enables measurement of fingermarks deposited on infrared-opaque substrates (such as glass). [1] The best possible spatial resolution is achieved with the technical capabilities of the synchrotron, the increased signal to noise ratio provides increased sensitivity and spatial resolution for the complex analysis of fingermark residue. [2]

In this investigation, we have used infrared microscopy to probe the spatial distribution of the sebaceous and eccrine chemical components within latent fingermarks. Whilst conventional FTIR spectroscopy fitted with a focal plane array detector allowed imaging across a large area of the sample, synchrotron sourced ATR-FTIR was used for the complex analysis of fingermark residue at sub-micron pixel resolution. By imaging individual droplets across a fingermark ridge we have been able to prove that fingermark droplets have a varying chemical composition of hydrophilic and hydrophobic components, closely resembling an emulsion (see attached Figure 1).[3] These results advance our current understanding of fingermark composition, providing information which will assist in future research into fingermark residue and its interaction with fingermark detection methods.

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3. Dorakumbura BN, Boseley RE, Becker T, Martin DE, Richter A, Tobin MJ, et al. Revealing the spatial distribution of chemical species within latent fingermarks using vibrational spectroscopy. Analyst. 2018;143(17):4027-39. 10.1039/C7AN01615H

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