B29 Bomb Biometrics: Detection and Imaging of Markers Indicative of Explosive Compounds in Fingerprints

Cameron M. Longo, University at Albany-SUNY, Albany, NY 12222; Rabi A. Musah, PhD, State University of New York at Albany, Albany, NY 12222*

Learning Overview: After attending this presentation, attendees will gain insight into how mass spectrometric techniques can be used to identify contact with explosive materials based on fingerprints or fingerprint residues, as well as how mass spectrometry imaging can be used to connect this information to an individual using specific biometric data.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by discussing the potential value of evaluating the chemical content of fingerprints in addition to the physical pattern, specifically by highlighting an approach to identifying and correlating the handling of illicit or otherwise forensically-relevant compounds to an individual by using mass spectrometric techniques.

Fingerprints have been a common staple of the crime scene investigative processes for decades, and while they are extremely practical in establishing a connection to a specific person, a large portion of the available information present in a fingerprint is currently unutilized. Indeed, the chemical content of a fingerprint may hold a bounty of useful information pertinent to an investigation. This may include biomarkers indicative of a suspect's age and/or sex, medications or illicit drugs that they have ingested, or contact with other molecules. The use of a rapid, ambient ionization mass spectrometry technique would allow for fast screening that could be used to quickly flag molecules of forensic interest, while a robust imaging technique could reveal the spatial distribution of said markers and be used to link this evidence to an individual based on their unique fingerprint pattern. The work shown will demonstrate how direct analysis in real time mass spectrometry (DART-MS) can be used to quickly identify potential contact with explosive materials, while matrix-assisted laser desorption ionization mass spectrometry imaging (MALDI-MSI) can be used to map the spatial distribution of relevant markers and tie them to an individual with biometric information.

As proof of concept, dilute solutions of some common explosives or explosive precursors, such as TNT, tetryl, and nitroglycerin, were handled by subjects prior to deposition. Fingerprint residues were collected by rolling glass beads between the fingertips. The beads were submersed in solvent and sonicated briefly, after which the solvent was removed under vacuum to produce a concentrated residue. This residue was analyzed by using a JEOL AccuTOF mass spectrometer coupled with a DART-SVP ion source under conditions compatible with the compound being analyzed. Utilizing this method, peaks corresponding to either protonated whole molecules or fragments of molecules can be detected.

Fingerprints were deposited onto ITO-coated conductive glass slides, and a matrix solution of either CHCA or 9AA was applied. The sample was analyzed in two-dimensions using a JEOL S3000 SpiralTOF MALDI mass spectrometer in either positive or negative spiral mode at a spatial resolution typically between 70-80 μm. Using this method, peaks corresponding to the explosive material can be detected. In addition, 2D ion renderings can be generated for each peak, displaying the spatial distribution of each ion detected. These are identical to the spatial distribution of endogenous molecules such as fatty acids, which aids in demonstrating the direct link between the chemical information and the donor of the fingerprint.

The chemical information stored within a fingerprint could be of great value to investigators, though it generally remains underutilized. The mass spectrometric techniques shown here can probe this content to provide additional information in investigations of crimes. DART provides this in a rapid way and can be used as a potential screening method, while MALDI is able to link this chemical information definitively to an individual using biometric data and comparisons to the patterns established by endogenous compounds.

Explosives, Mass Spectrometry, Fingerprints