A3 Gunshot Residue Signal Decay and Back-Extraction Analysis Using Thermal Desorption Ion Mobility Spectrometry

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After attending this presentation, attendees will gain perception of the capabilities and functionality of the thermal desorption ion mobility spectrometer, focusing to illuminate the ability of the Thermal Desorption Ion Mobility Spectrometry (TD-IMS) to analyze, qualify, and quantify organic gunshot residue.

This presentation will impact the forensic science community by supplying a sturdy and portable preliminary testing device to analysts in the field, thus limiting the possibility of contaminating evidence en route to the lab. Evidence used in the TD-IMS can be recycled as well, allowing more to be done with less.

Current popular methods of gunshot residue analysis include Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectroscopy (EDS). SEM characterizes the morphology of particulates to determine if they are spherical, a sign that vaporized metallic Gunshot Residue (GSR) condensed upon cooling. EDS identifies whether these spheres consist of barium, antimony, and lead, the three most common metals in GSR. However, with lead-free bullets on the market and odd morphologies of particles possible, other methods of analysis would prove beneficial.

TD-IMS is primarily used as a field device for detecting narcotics and explosives. It has great potential for analysis of Organic Gunshot Residue (OGSR), an often-overlooked source of evidence from propellant combustion. The focus of this project was to develop a hand-swabbing method in which one swab could be interrogated using TD-IMS, back-extracted, then analyzed using Gas Chromatography-Mass Spectrometry (GC/MS). The ability to successfully extract after a thermal desorption cycle depends on the amount of organic material collected on the swab, the contact area of the desorber with the swab, and the efficiency of the thermal desorption process.

First, each thermal desorption cycle loss was evaluated using spiked swabs. Several different target analytes were studied including nitroglycerin and diphenylamine, both single-based gunshot surveillance standards. For each analysis, a swab was spiked with a known amount of the target analyte at the parts-per-million level in solvent. The swabs were allowed to dry and then repeatedly subjected to TD-IMS. In all cases, the decay of the peak of interest followed a second-order kinetics model. This suggests that the swabs could be analyzed first by TD-IMS and then extracted for further instrumental confirmation.

GSR field samples from a firing range were similarly analyzed and distinctive TD-IMS patterns were observed.

An isopropanol wiping method was developed to collect hand samples from a random population that also purposely included those who handle weapons and ammunition such as gun shop owners and police officers. This database was used to establish a range of typical background levels of compounds of interest and to develop TD-IMS signal-to-noise ratios. Results to date will be discussed, as will results from authentic post-firing samples.

This research displays the potential of TD-IMS as a screening method for detection of organic gunshot residue. A single swab collected post-firing can be used for both screening and confirmation, a luxury not afforded by older color testing methods and current SEM/EDS sample collection procedures. The work also further validates the potential of organic components of GSR as viable analytes in forensic GSR testing.

Gunshot Residue, TD-IMS, Field Instrument

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