B72 A Single Extraction, Consecutive Detection of Organic and Inorganic Firearms Discharge Residue Using Thermal Desorption Gas Chromatography/ Mass Spectrometry (TD-GC/MS) and Inductively Coupled Plasma/Mass Spectrometry (ICP/MS)

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After attending this presentation, attendees will be familiar with a method that allows for characterization of both organic and inorganic Gunshot Residue (GSR) using a single sample.

This presentation will impact the forensic science community by presenting an alternative method for the analysis of Firearms Discharge Residue (FDR) using one hand swab sample.

FDR consists of unburnt and partially burned particles and particulates arising from the primer, cartridge, propellant powder, grease, and lubricant. GSR (an inorganic fraction of FDR) is currently associated principally with the primer and consists of particulates with a characteristic size, morphology, and chemical composition. GSR is detected by Scanning Electron Microscope Energy coupled to Dispersion X-ray (SEM/EDX) analysis with a methodology described by the American Society for Testing and Materials (ASTM) method E-1588-16a. Samples for this type of analysis are collected using a small adhesive stub. Some of the known limitations of this methodology include secondary transfer and concerns arising from newer primer formulations that minimize heavy metals, such as lead. These concerns, coupled with the development of new methods for sample introduction and advanced MS, have led to increased interest in the organic constituents of FDR or Organic Gunshot Residue (OGSR). These residues arise from the propellant, grease, and lubricant and include compounds such as stabilizers (diphenylamines), dinitrotoluenes, and methyl and ethyl centralite. The energetics (nitrocellulose and nitroglycerin) are not routinely used as target analytes for post-firing characterization. While the ability to characterize OGSR could at some point become viable for forensic laboratories, an even better analytical approach would facilitate characterization of both GSR and OGSR from a single sample. Here, a method is described using Thermal Desorption-Gas Chromatography/Mass Spectrometry (TD-GC/MS) to characterize OGSR, followed by acid extraction of the same swab and elemental analysis using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS). The advantage of this method is that a single swab is used for both analyses; this is countered by the loss of morphological information obtained from SEM.

For this project, hand swabs were collected under an approved Institutional Review Board (IRB) protocol using isopropanol and clean room wipes. The collection area was ~1cm x 1cm and all surfaces of both hands were sampled and concentrated into this small surface area. The swab was placed in a thermal desorption probe and inserted directly into the injection port of the GC/MS. A selected ion mode analysis was employed targeting 2, 4-di-tert-butylphenol, 2, 4-dinitrotoluene, diphenylamine, methyl centralite, ethyl centralite, and dibutylphthalates, all common OGSR target compounds. After desorption, the swab was removed and subjected to a single 2% nitric acid extraction, followed by ICP/MS analysis. The method was developed using standards and swabs collected after shooting 10-20 rounds of a variety of weapons and ammunition. Subsequently, samples were collected from known shooters and non-shooters for analysis. Overall, diphenylamine, ethyl centralite, lead, barium, and copper

were detected in most cases with three or more shots discharged; the results from smaller caliber weapons were variable with ethyl centralite, lead, and copper predominating. This presentation will describe method development, validation, experimental conditions, and results across a range of authentic sampling situations.

Firearms Discharge Residue, OGSR, GSR