B30 Direct Thermal Desorption Coupled to Gas Chromatography/Mass Spectrometry (GC/MS) for the Characterization of Organic Firearm Discharge Residues

William Feeney, BS, 801 Second Street, New Martinsville, WV 26155; Lindsay Cheeseman, 108 3rd Street, Apt B, Morgantown, WV 26505; and Suzanne Bell, PhD, West Virginia University, Oglebay Hall, Rm 208, 1600 University Avenue, Morgantown, WV 26506-6121*

After attending this presentation, attendees will understand how thermal desorption may be used to characterize organic Gunshot Residue (GSR).

This presentation will impact the forensic science community by providing an overview and method validation data for a new way of characterizing organic GSR using GC/MS instrumentation.

The development of powerful new hybrid mass spectrometry systems has led to renewed interest in targeting the organic constituents of Firearms Discharge Residue (FDR). Several methods have been published in the last decade reporting on the analysis of organics found in FDR using Liquid Chromatography/Mass Spectrometry (LC/MS). The mass spectrometers used include Time-Of-Flight (TOF), quadrupole Time-Of-Flight (qTOF), and Triple quadrupole (QqQ) designs. For LC/MS analysis, a substrate such as a hand swab is typically extracted, concentrated, and introduced into the chromatographic system and analytes such as Diphenylamine (DPA), ethyl and methyl centralites, and dinitrotoluenes and other diphenylamines are detected. Forensic laboratories are adopting advanced LC/MS instrumentation, but in most cases these instruments are devoted to toxicological assays, which presents real-world limitations for adaptation to routine casework. Conversely, forensic laboratories often have greater access to GC/MS, but the detection limits of even the best of these systems for extracted samples is often too high to be used with the same type of extracts often used for LC/MS. This problem is difficult to alleviate procedurally, even using multiple extractions, drying, and selected ion MS; however, thermal desorption has already been shown to be useful as an inlet for FDR types of analysis using ion mobility spectrometry and pre-concentration using Solid-Phase Microextraction (SPME) and similar techniques.

This study reports on the development of a direct thermal desorption method as an inlet for GC/MS analysis of hand swabs collected on clean room wipes. A commercial Thermal Separation Probe (TSP) was used to hold swabs as they were placed directly into the injection port of the GC. Desorption proceeded over ~30 seconds while the GC column was held at room temperature. Samples were then eluted using a temperature program and detected using Selected Ion Monitoring (SIM) of three to four ions per target compound. An internal standard and surrogate spikes were utilized for semi-quantitative analysis and recovery monitoring, respectively. Ethyl centralite and diphenylamine were the most frequently detected compounds, with swab recoveries estimated at >65% based on surrogate spike data. Limits of detection corresponded to µg quantities, which is comparable to what is expected to be deposited by realistic forensic shooting scenarios. The results for several shooting experiments using different weapons, ammunition, and number of shots will be presented, along with method development and validation, figures of merit, and instrumental parameters.

Organic Gunshot Residue, Thermal Desorprtion, GC/MS