B122 Detection of Organic Components of Gunshot Residue (GSR) of Carbon SEM Stubs by Raman Spectroscopy

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After attending this presentation, attendees will better understand the analysis of organic components of GSR by Raman spectroscopy and the increased probative value of the data produced. Attendees will further understand initial efforts at development of an analytical protocol which can identify both organic and inorganic components of GSR using a standard 12.7mm Scanning Electron Microscopy (SEM) stub with carbon adhesive tab.

This presentation will impact the forensic science community by demonstrating the applicability of Raman spectroscopy to an analysis scheme which currently relies on Scanning Electron Microscopy with Energy-Dispersive X-ray Spectrometry (SEM/EDS) to identify individual particles having a specific morphology and elemental composition.

Current methods of GSR analysis concentrate on identification of the inorganic components of ammunition primers. Single particles with morphology indicative of formation in a high heat environment and containing the elements lead, barium, and antimony are considered characteristic of GSR. SEM/EDS is the widely accepted method to determine both elemental composition and morphology. Although this is a very effective method, the probative value of inorganic GSR analysis is limited. Not only are there limitations on the sample containing three component particles, but current and future formulations of "green" lead-free ammunition will lead to an increasing probability of false negatives.

The organic component of the GSR has not been utilized during analysis thus far. Chromatography with mass spectrometry has been proposed as a way to identify the components of these organic compounds, but at the expense of the sample. There would be no way to identify if the inorganic components are present after this examination. With recent advancements in Raman spectroscopy technology, new techniques are able to be developed.

This study introduces early research into the ability to detect and characterize organic residues deposited on the standard 12.7mm SEM stubs, while still allowing for subsequent traditional SEM/EDS analysis.

Previously published results of the viability of organic GSR analysis by Raman spectroscopy were reproduced by firing several types of ammunition at short range into cloth targets and confirming the presence of particles of partially combusted propellant. The spectra of the unfired propellant were compared to the partially burnt propellant picked off of the fabric and were compared and observed to be consistent. To expand the scope of the initial analysis, 12.7mm SEM stubs with adhesive carbon tabs were mounted three inches on either side of the cloth target. Spectra consistent with results from unburnt propellant were able to be obtained by targeting individual particles on the surface of the carbon tab. Positive results show that it is possible to identify organic GSR components even in the presence of broad, dominant carbon D band at 1,350cm^{-1} and G band at 1,582cm^{-1}. By using this non-contact and non-destructive approach, the GSR stub is available to be used for subsequent analysis on the SEM/EDS.

The next phase in the research involved a more realistic collection scenario. After each test firing, the shooter's hands were sampled with individual GSR stubs in accordance with normal collection of inorganic GSR. Initial manual scans detected a small number of particles consistent with organic components of the propellant of the discharged ammunition. Although the initial number of particles detected was small, the findings are considered an important proof of concept that organic portions of GSR can be detected on samples using existing collection protocols.

Future areas to be researched are the optimization of instrument parameters to be able to accurately detect organic GSR particles, correctly characterize and classify particles by propellant type, and implement the use of software mapping features to set up an automated run similar to the inorganic GSR analysis by SEM.

This study indicates that it is possible to detect organic components of GSR on a standard 12.7mm SEM stub with adhesive carbon tab using already existing collection techniques. Since organic GSR shows far more variation both by manufacturer and even by individual types of ammunition by the same manufacturer, it may be possible to identify differing types of propellants, greatly increasing the probative power of GSR analysis.

Gunshot Residue, Raman, Organic

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