B195 Novel Capabilities for Forensic Gunshot Residue (GSR) Analysis Through Exploitation of Glass Found in Primer Mixes

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After attending this presentation, attendees will be aware of glass-containing GSRs and be able recognize and identify this particle type in casework. The value of advanced analytical techniques for GSR analysis will be demonstrated and attendees will be made aware of the potential to associate these particles with a firearm source.

This presentation will impact the forensic science community by alerting GSR examiners of a new type of particle that demonstrates strong association with a firearm source. In particular, this presentation illustrates that a high probative value can be attributed to 0.22 caliber GSR and also demonstrates a new approach that can be used by GSR examiners to link GSR with unfired ammunition or spent cartridge cases; this capability is very valuable, but traditional approaches suffered from a relatively high degree of uncertainty.

The highest evidential level of the current American Society for Testing and Materials (ASTM) guidelines for identifying primer GSR involves detection of the characteristic elements Lead/Antimony/Barium (Pb/Sb/Ba) or Lead/Barium/Calcium/Silicon/Tin (Pb/Ba/Ca/Si/Sn) in individual particles by Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM/EDS).[1] In Australia, 0.22 caliber weapons are common and rimfire ammunition is most often used in firearms offenses and suicides. Up to 84% of 0.22 rimfire ammunition has a primer that does not include all of the elements required to produce characteristic particles; in particular Sb, Sn, or Ca are often absent; however, the majority of 0.22 caliber ammunition manufacturers include ground glass as a frictionator in their primer formulations.[2] This glass becomes encrusted with Pb and/or Ba when the ammunition is fired, producing particles of glass-containing GSR (gGSR).[3]

The research described in this presentation proposes that Pb/Ba/glass gGSR be considered for acceptance as a member of the characteristic GSR particle class. Evidence will be provided demonstrating that this particle type could be as probative as Pb/Ba/Sb in identifying a particle's source. The gGSR particles also have the potential of adding extra value to GSR analysis, as glass frictionators from different ammunition brands have been shown to often have different elemental signatures, and due to the stability of glass during the firing process, it may act as a means of linking samples of GSR together, to a cartridge case, or to a source ammunition.[4]

The research that will be presented has two primary objectives: (1) to assess the probative value of gGSR particles with regard to their association with a firearm origin; and, (2) to investigate the chemical variation inherent in glass frictionators from different ammunition manufacturers and the scope for linking gGSR with suspected source ammunition or spent cartridges.

Objective 1 was accomplished by using SEM/EDS to compare glassy GSR to known non-firearm sources of GSR-like particles, such as fireworks and brake pad dust. With the exception of other cartridge discharge residues, such as from some older industrial nail guns, no sources of particles indistinguishable from gGSRs were found.

Objective 2 was investigated using SEM/EDS, Time-Of-Flight/Secondary Ion Mass Spectrometry (TOF/SIMS) and Sensitive High-Resolution Ion Microprobe (SHRIMP). First, a survey of the variance of the elemental composition of frictionators across the ammunition market was conducted. Second, experiments were performed to determine whether the elemental composition and stable isotope ratios of the frictionator are preserved during ammunition discharge and whether the composition could be used to link residues to their ammunition source. The application of statistical and chemometric techniques were used to explore variation across the ammunitions available on the Australian market, where it was shown that the total combined pairwise discrimination power of TOF/SIMS, SHRIMP, and SEM/EDS was 97.8% and the discrimination power of TOF/SIMS alone was 94.1%. It was shown that the composition of glass is conserved through firing, and that post-firing samples could often be unambiguously matched to pre-firing samples with the assistance of advanced chemical techniques.

This presentation will alert GSR examiners to a new type of particle that displays strong association with a firearm source. In particular, it reveals that a high probative value can be attributed to 0.22 caliber GSR. It also demonstrates a new approach that can be used by GSR examiners to link GSR with unfired ammunition or spent cartridge cases; this capability is valuable but traditional approaches suffered from a relatively high degree of uncertainty.

Reference(s):

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Glass-Containing GSR, Characteristic Particles, Advanced Chemical Analysis