E74 Analysis of Bullet Wipes by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectroscopy (SEM/EDS)

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The goal of this presentation is to inform the forensic community that the Gunshot Residue (GSR) coating applied to a bullet when fired and then deposited on target (bullet wipe) can have evidentiary value in some shooting cases.

This presentation will impact the forensic science community by explaining how the analysis of bullet wipes by SEM/EDS can potentially identify the source firearm, depending on the ammunition, both current and historical, by comparing the GSRs of the bullet wipe as well as within the firearm bore.

Coatings of GSR on discharged bullets have been known for many years. As a bullet travels down the bore of a firearm, GSR particle adherence to the bullet's surface occurs, the particles then being deposited on the target upon its strike. Indeed, the identity of a bullet entrance defect in the target frequently depends on the bullet's wipe on that surface and the wipe is often identified by a chemical test.[1] Sloughing off of GSR particles from the bullet's surface also likely occurs during its travel from the muzzle to target.[2]

Burnett described an antistatic organic compound shown to be effective for viewing fabric samples in the SEM.[3] There is little to no charging in the SEM under high vacuum, but it is stable under a focused electron beam rastering for elemental analysis by EDS.

For most caliber bullets with perforated fabric targets, the fabric with the entire bullet wipe area can be excised and mounted on a 13mm D SEM stub. Three drops of the antistatic compound are dripped onto the sample, followed by a light dabbing with filter paper to remove the excess. There is an insignificant GSR transfer to the filter paper. Pressing a sticky GSR sampler on the bullet wipe will pick up GSR, but this is not a good sample representation as excising the entire, or part of the, defect area with the bullet wipe and mounting on an SEM stub. Bullet-wipe GSR tenaciously adheres to fabric fibers. When the defect area is covered with dried blood, the blood can be removed with little apparent disruption (either of GSR removal or chemical change) of the bullet transfer area by a bleach solution of sodium/calcium hypochlorite.[3]

During the discharge of a bullet through the firearm bore, the primer GSR mixes with previous primer deposits from the bore surface.[4] Many of the muzzle GSR particles generated by the current shot are a mixture of GSRs from previous shots.

Many ammunition manufacturers produce lead-free primers of different inorganic compositions.[5] Examination by SEM/EDS of both the bullet wipe and bore GSR could identify bullet source in some cases if a leadless primered ammunition was used with the current shot or previous shots. Repeated shots with leadless primered 38 caliber Remington® UMC Leadless cartridges increases the contribution of potassium with each shot of the resultant bullet wipe GSR.

One fabric sample of bullet wipe adjoining areas revealed different compositions (Lead, Antimony, Barium (PbSbBa) and Pb) of the GSR. The Winchester® bullet in this test had an exposed lead base. This suggests there is a stable component of gas flow behind the bullet as it travels down the bore of the firearm. The volatized lead from the base of the bullet preferentially flowed, likely through an eddy, through a groove in the bore rifling at the side of the bullet.

Reference(s):

1. Haag L.C. 2006. Shooting incident reconstruction. Elsevier, Boston.
2. Gerard R.V. McVicar M.J. Lindsay E., Harvey E. 2011. The long range deposition of gunshot residue. *Can. Soc.Forensic Sci*. 2011. 44(3):97-104.
3. Burnett B.R. 2016. The effect of skin debris on gunshot residue (GSR) detection from hand samplers. Proceedings of the American Academy of Forensic Sciences, 68th Annual Scientific Meeting, Las Vegas, NV. 2016, B200.
4. Charles S. Nys B. Geusens N. 2011 Primer composition and memory effect of weapons-some trends from a systematic approach in casework. *Forensic Science International. 212:22-26*.
5. Oommen et al., Pierce S. 200. Lead-free primer residues: A quantitative characterization of Winchester WinClean, Remington UMC Leadless, Federal BallisticClean and Speer Lawman CleanFire handgun ammunition. *Journal of Forensic Sci*. 51(3)509-519.

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