B175 Gunshot Residue (GSR) Identification Errors and Sample Significance

Bryan R. Burnett, MS, Meixa Tech, PO Box 844, Cardiff, CA 92007-0844*

The goal of this presentation is to describe analyst errors made in the interpretation of spectra by Energy Dispersive X-ray Spectroscopy (EDS) of GSR samples in the Scanning Electron Microscope (SEM), as well as population statistics as they relate to GSR sampling.

This presentation will impact the forensic science community by describing errors in the interpretation of EDS spectra in GSR particle analysis made in case work and in determining sampler significance for GSR.

SEM/EDS is being used by crime laboratories worldwide for the analysis of GSR samples in shooting cases. Unfortunately, the operators of these instruments often have inadequate training for the interpretation of EDS spectra, usually relying solely on software identification of peaks. Newbury analyzed this problem, but did not focus on mistakes made in GSR analysis.[1] Element peaks are misidentified, missed, or fabricated.

Case 1: Arsenic with the major sulfur peak confused for lead.

Case 2: Mistaken assignment of trace antimony in particles with major barium and trace calcium.

Case 3: Misreporting spectra due to software misplacement of element symbols on spectra.

Case 4: Missing element peaks that are obscured by peaks of other elements.

Case 5: Claim of trace element presence (antimony or lead) using presumptive (thumbnail) spectra listings without confirmation spectra.

Case 6: Assignments of particle spectra to consistent, "highly specific" (= characteristic), "unique" (= characteristic), and characteristic GSR.

Case 7: Ignoring a major contribution of iron (+ trace copper) in antimony/barium particle spectra (= friction-brake particles) and calling these particles GSR.[2]

Case 8: Failure to identify the source of trace elements represented in a GSR spectrum. Barium sulfate particles are ubiquitous in the urban environment and often well-populate a sampler. Thus, nearby barium-containing particle(s) may contaminate a particle's spectrum. This can occur for the consistent GSR particles composed of lead and antimony which produces an erroneous assignment of characteristic GSR.

For many crime lab analysts, there is a failure to consider statistical significance of a GSR particle burden of sampler. The SEM/EDS analysis results of the (usually) two samplers from a suspect (left and right hands) require statistical criteria for acceptance of these samplers as representative of a GSR population that existed on the suspect's hands prior to sampling. A single-characteristic GSR particle without supporting consistent GSR on a sampler cannot be separated from a rare contamination event or outlier.[3] This is especially true due to possible GSR contamination in the police environment from officers, who occasionally qualify their firearms, or GSR-contaminated suspects who have been in the police environment previous to the suspect. The criterion for a GSR sampler to have a significant burden of characteristic (Lead, Antimony, and Barium (PbSbBa)) GSR particles is three (except perhaps in military cases); however, the criterion for assigning significance to a sample when it has one characteristic GSR particle with two or more consistent GSR particles has not been established.[4]

There is no reason not to combine the two samplers from a suspect's hands for the determination of sampler significance.

Reference(s):

1. Newbury D. Mistakes encountered during automatic peak identification of minor and trace constituents in electron-excited energy dispersive x-ray microanalysis. 2009. *Scanning*. 31:1-11.
2. Torre C., Mattutino G., Vasino V., Robino C. Brake linings: A source of non-GSR particles containing lead, barium and antimony. 2002. *Journal Forensic Sci*. 47(3):494-504.
3. Bernet V., Lewis T. *Outliers in statistical data.* 3rd edition 1994. John Wiley and Sons, New York.
4. Wright D.M, Trimpe M.A. Summary of the FBI Laboratory's gunshot residue symposium. 2006. *Forensic Sci. Communications*. 8(3):1-17.

Gunshot Residue, Errors, Significance