E2 A Combined Method of Detection for Organic and Inorganic Gunshot Residue (GSR)

Lauren Gandy, 441 Alafaya Woods Boulevard, Apt F, Oviedo, FL 32765; Molly Terry, National Center for Forensic Science, PO Box 162367, Orlando, FL 32816-2367; and Candice Bridge, PhD, National Center for Forensic Science (UCF), PO Box 162367, Orlando, FL 32816*

After attending this presentation, attendees will better understand current GSR presumptive test limitations and alternative GSR presumptive testing methods using reliable colorimetric color spot tests that do not affect subsequent analysis using common instrumentation methods.

This presentation will impact the forensic science community by proposing an alternative GSR presumptive test method using reagents with long storage life, based upon color mechanisms with color production specific to compounds in GSR, allowing simultaneous testing of inorganic and organic GSR. This will impact crime scene analysis domestically and internationally for deployed forensics units to rapidly analyze samples and provide a rapid and dependable response.

GSR is comprised of burned and unburned smokeless powder particulates and metallic particles that are expelled from the muzzle of a firearm in a vaporous plume; these are deposited onto the face, hands, and clothing of the shooter and can be used to potentially identify a suspect in a criminal investigation. Currently, crime scene technicians use an aluminum stub with a carbon adhesive to collect these particulates, further subdivided into Organic (OGSR) and Inorganic (IGSR). Presumptive GSR tests use colorimetric determination to identify the presence of some OGSR and IGSR while confirmatory GSR tests use Scanning Electron Microscopy coupled with Energy Dispersive X-ray spectroscopy (SEM/EDX) to analyze the type of metal present. The SEM/EDX is used to visualize specific topographical morphology of the metallic particulates and confirm an elemental composition of the traditional lead-barium-antimony composite. Presumptive IGSR tests have limitations due to their specificity to lead and not to GSR and nullification in the case of lead-free primers. Presumptive OGSR tests produce false positives to environmental contaminants and are also non-specific, producing color responses to common nitrated compounds. Simultaneous testing for I/OGSR currently requires that the already miniscule sample amount be split into two portions, impacting downstream analytical techniques.

The goal is to develop a presumptive I/OGSR colorimetric test that does not interfere with the classic SEM/EDX analysis of IGSR and would allow the simultaneous detection of GSR without splitting the sample and thus utilizing all components available. Organic color spot tests such as nitrous acid, 4-nitrosophenol, and sodium borohydride are explored. The tests are evaluated in four stages on differing samples: (1) on individual compounds contained in GSR and the environment for specificity; (2) on limited mixtures of three to four inorganic and organic components to evaluate effectiveness of color production and duration; (3) on all-inclusive mixtures of known inorganic and organic GSR components to evaluate using the SEM/EDX for the presence of inorganic components; and, (4) on real-world samples for proof of theory and determination of limit of detection.

The three colorimetric tests above passed the first three stages; however, 4-nitrosophenol and sodium borohydride passed all stages with specificity, visible differentiation of color production, and did not adversely affect the elemental composition of lead-barium-antimony for lead ammunition and zinc-titanium-potassium-copper for lead-free ammunition. This provides the foundation that a simultaneous test for I/OGSR can be used both in the field for rapid determinations and, subsequently, in the laboratory for confirmation of the elemental analysis.

Gunshot Residue, Colorimetric, Spot Test