B120 The Probative Value of Very Small Particles (VSPs) Adhering to Common Items of Physical Evidence

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After attending this presentation, attendees will appreciate the potential probative value of VPSs, present as dust on or within common items of physical evidence.

This presentation will impact the forensic science community by increasing awareness of the potential value of such particle combinations on common items of physical evidence, as well increasing the awareness of the computational methods that can be applied to recognize associations and measure the strength of associations based on these combinations.

Particle combination analysis uses co-occurring particles to test alternative attribution hypotheses. One application of particle combination analysis is the exploitation of the thousands of VSPs that are found in and on items of evidence, using these particles to test associations and enhance probative value. The combinations of VSPs are so complex that, until recently, there was no practical method to identify and interpret these combinations.

This presentation will cover the application of statistical methods of particle combination analysis to Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM/EDS) analytical results for very small particles recovered from the surface of common items of physical evidence, such as handguns, cell phones, ski masks, and drug packaging.

VSPs were collected from actual items of evidence from cases in one jurisdiction where detectives had determined that the items were no longer of value and had approved them for disposal. Particles were harvested from plastic drug packaging by directly applying commercially prepared SEM stubs analogous to those commonly used in protocols for the recovery of possible Gunshot Residue (GSR) from a subject's hands. Clean room swabs, slightly moistened with pre-filtered distilled water, were used to recover VSPs from handguns, cell phones, and ski masks. Two separate specimens were recovered from each evidence item.

The SEM stub specimens from drug packaging were suitable for SEM/EDS processing without further preparation. The swab specimens were prepared for SEM by extraction of particles into an aqueous suspension, followed by low-vacuum filtration onto 0.4 micrometer pore size 13mm polycarbonate filters and mounting on SEM/EDS stubs.

For each specimen, up to 10,000 VSPs were individually characterized by semi-automated SEM/EDS analysis, binning the analytical response for each particle into 18 X-ray energy bins corresponding to a set of 18 elements. The data sets were filtered to reduce noise represented by: (1) particles having no dominant elemental composition detected under the analysis conditions; and, (2) elements present in low quantities for any given particle.

Sets of Target Particle Types (TPTs) were defined based on normal mixture modeling using a training set composed of random sampling from all sources. Multinomial distributions were defined for each source based on the numbers of particles corresponding to each of the TPTs. For comparison of TPT profiles, the probability density of the observed count in a test specimen was assigned in each of the N multinomial densities (corresponding to each of potential sources). This probability was used as the measure of correspondence to each of the reference sources.

The probabilities can be used for classification or for ranking of candidate sources as in a library search.

Measurements of probative value were defined using a Bayesian classifier applied to the multinomial probability densities, assuming an equal prior among all N classes. This results in posterior probabilities obtained using the classifier for all N sources. A corresponding likelihood ratio was calculated as a measure of evidential weight, based on assumptions of the representativeness of the N sources.

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Particle Combination Analysis, Trace Evidence, Evidential Value