E52 High Order Trace Transfers: Considerations for the Analysis of Sub-Visible and Nanoparticles

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The goal of this presentation is to illustrate both the strengths and considerations that must be taken into account as the size of particles being analyzed decreases to sub-visible and, ultimately, nanoscale evidence.

This presentation will impact the forensic science community by providing a framework upon which increasingly smaller traces can be analyzed and interpreted.

As trace evidence analysts begins to exploit the evidentiary value in finer particles, particularly those that would be considered sub-visible (<1µm-100µm) and nanoparticles (<1µm), the traces become more difficult or impossible to visually monitor. To this end, evidence collection teams, examiners, and evidence custodians must be aware of the potential that collecting, sampling, analyzing, and even packaging may have on the transfer of evidence. In addition, those responsible for the interpretation of such traces must also be aware of the potential for secondary, tertiary, and higher order cross transfers. Maintaining this awareness becomes challenging when the particles are invisible to the unaided eye and even more challenging when the particles cannot be resolved by stereomicroscopy. The use of sample blanks, purpose-built laboratory environments, and more rigorous environmental monitoring represent a few of the factors that must be considered when dealing with smaller particles and finer features. Such considerations are presently less significant when dealing with typical trace evidence samples since current traces can be visually located and tracked throughout an analysis, using either an unaided eye or low-magnification stereomicroscopy.

As a means by which to study the transfer of subvisible particles, a commercially available fluorescent detection spray was examined. This substance is composed of 2µm-5µm particles of zinc sulfide in a light hydrocarbon oil. Zinc sulfide is a fluorescent indicator component that is used as a visual illustration of contact transfers between two objects. Such evidence of contact between objects may be visualized through illumination by long-wave ultraviolet light, which stimulates luminescence in the powder. This research provides a microanalytical characterization of the zinc sulfide particles and offers multiple independent approaches by which this powder (or other fine particles) may be detected and specifically identified in quantities from major to trace.

This definitive identification provides a means by which a field test that presently provides a presumptive result (one that is largely limited to investigative work and is based on a relatively crude visualization scheme) can be converted into a court-acceptable result by providing a specific identification. This identification process can be adapted to the detection of microscopic particles of zinc sulfide, thus increasing not only the specificity of the identification but also the sensitivity of the method. Using an adapted Gunshot Residue (GSR) sampling method and automated Scanning Electron Microscopy (SEM) analysis routine, individual particles of the fluorescent detection spray are readily detected.

While such approaches can increase the sensitivity of a test by three orders of magnitude, they also raise significant questions about cross contamination and higher order transfers (e.g., tertiary and quaternary transfers). This research will provide a demonstration of a tenth-order trace transfer using this detection powder. The potential for such transfers raises significant considerations that become particularly relevant to the analysis of increasingly smaller particles as well as the trace evidence of the type and size presently analyzed in a typical crime laboratory.

Nanoparticle, Clue Spray, High-Order Transfer

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