A152 Use of Computer Controlled Scanning Electron Microscopy (CCSEM) Methods for the Analysis of Small Particles Adhering to Carpet Fiber Surfaces

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After attending this presentation, attendees will understand how fine particles, adhering to the surfaces of individual carpet fibers, can be recovered and quantitatively analyzed by SEM/EDS and, in its current state of development, how this capability can be applied and integrated into conventional forensic trace evidence analysis.

This presentation will impact the forensic science community by demonstrating the feasibility of the analysis of these "piggy back" particles, and how they can be used to remove fundamental class-level limitations on the probative value of trace evidence and provide an independent quantitative means to test hypotheses of common origin.

Very small particles are ubiquitous in our environment and are virtually ignored by forensic science (gunshot residue being a notable exception). These particles range in size from an order of magnitude smaller than conventional trace evidence, down to the molecular level (now routinely exploited through DNA analysis). We move around in a soup that is a combination of these very small particles and they represent an extraordinary, largely untapped resource for forensic associations and source attribution. The combinations of these particles are so complex that until recently there was no practical method to identify and interpret these combinations. Particle combination analysis (PCA) is a new capability that focuses on these methods. This project involves the application of PCA as a means to objectively verify and improve traditional trace evidence analysis of fibers.

An innovative instrumental trace evidence analysis approach that applies the PCA concept to the recovery and quantitative SEM/EDS analysis of fine particles found adhering to the surfaces of larger trace evidence particles is described. Ultimately this approach could fundamentally change the probative value of trace evidence from one of class association to one of highly individual, testable associations (akin to those arising from multiple-transfers of uncorrelated traces, or the co-occurrence of independent, highly variable events).

Methods were developed to quantitatively remove fine particles from carpet fiber surfaces and to prepare the particles for SEM/EDS analysis.

To assess within-carpet variability, computer controlled SEM analyses (CCSEM) were conducted on fine particles removed from three different areas from each of nine carpets (three domestic, three automobile, and three commercial carpets). From each of the three areas on each of the nine carpets, a set of ten carpet fibers was used to define the "known" or target fine particle profile of the carpet itself. Three individual fibers from each of the 27 areas were then used as test fibers, each representing a single recovered transferred fiber. To explore between-item variation, a broader survey of an additional twelve carpet particle profiles was conducted.

Principal findings from these studies were:

- Fine particles are present on the surfaces of individual carpet fibers.
- These particles can be recovered nearly quantitatively for CCSEM analysis by extraction with reagent ethanol.
- Quantities of particles adhering to individual carpet fibers varied from a few hundred to greater than 4000 (the maximum number examined).
- Particle classification schemes currently in use for environmental CCSEM applications are broad compared to variations in elemental composition seen among the individual CCSEM particle spectra.
- Carpets vary widely in the types and quantities of small particles adhering to their fiber surfaces.
- Particle distributions from the individual test fibers could not be explained based on a hypothesis of unbiased statistical sampling from a population defined by the target particle profile.
- Highly characteristic, semi-quantitative patterns of particle types found in target particle profiles were consistently represented in the particle distributions from individual test fibers from the same carpet, and consistently absent among those from different carpets.
- Based on these findings, particle distributions found on carpet fibers can contribute substantially to the weight of evidence linking fibers to a specific carpet.
- Further studies are needed to better understand this type of evidence, including: (a) the sources of within-item variation, (b) the effects of alternative methods of particle classification, and (c) the extent of between-item variation.

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