B85 Differential Sampling of Footwear to Separate Alternative Particle Signals

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After attending this presentation, attendees will understand the method and potential contribution of the differential sampling of footwear as a means of separating sets of small particles that have accumulated as a result of exposures to different environments at different times.

This presentation will impact the forensic science community by providing an efficient, practical method to separate loosely, moderately, and tightly held particles from the surfaces of footwear. The inter-comparison and subtraction of these different particle sets will provide a means to separate alternative particle "signals" (as, for example, when subtracting a background spectrum in Infrared (IR) spectroscopy).

The separation of particle signals arising from different sources is one of the enabling operations for Particle Combination Analysis (PCA).[1] Although it is well recognized that criminals track dusts to and from every crime scene, dust particles on a suspect's shoes are very seldom used as evidence linking the accused to the crime. The major obstacle preventing the use of this type of evidence is that the shoes have mixtures of particles arising from activity before, during, and after the crime itself.[2] Methods separating the evidentiary particle "signal" from background noise would enable a powerful new and widely applicable forensic capability. This capability would augment traditional footwear pattern evidence with objective quantitative associations, addressing one of the specific issues raised in the 2009 National Academy of Sciences (NAS) Report, Stregnthening Forensic Science in the United States – A Path Forward. To help pursue this possibility, methods have been developed and tested that employ a series of successively more aggressive particle sampling protocols to separate loosely held, moderately held, and tightly held particles from the surfaces of footwear.

Two distinctly different and commonly encountered types of shoe soles were used in this study: athletic shoes (with flexible rubber soles) and work boots (with hard rubber soles). Eighteen new pairs of shoes of each type were sequentially exposed by walking a distance of 250m in three outdoor environments. Environments were evaluated and selected based on a well-defined accessible path and the presence of particle populations that were: (1) individually diverse; and, (2) collectively distinguishable from one another by defined qualitative and quantitative particle characteristics. Separate pairs of shoes were used for single-environment exposures (12 pairs, 6 of each type, 2 for each of the 3 environments) and sequential exposures to all three environments (24 pairs, 12 of each type, 2 for each of the 6 alternative sequences). Following exposures, particles from the outermost surfaces of the footwear soles were harvested by three progressively more aggressive methods: walking on paper (12 steps on butcher paper); electrostatic lifting (six lifts using a commercially available electrostatic lifter); and surface swabbing. Swabbing was conducted using lint-free clean room swabs moistened with 2% pre-filtered aqueous ethanol, resulting in particle suspensions. Particles on the paper and electrostatic lifts were collected using the same swabbing procedure, resulting in similar particle suspensions. Particle suspensions were fractionated by sieving and settling to recover fine sand and silt-sized particles. Particle types and quantities were measured by point counting using polarized light microscopy.

For each of the pairs of shoes, and for each of the successively more aggressive sampling methods, fine sand and silt-sized particles were recovered in sufficient quantities for quantitative analysis and comparison of soil minerals by polarized light microscopy ($n > 300$). Under the experimental conditions, athletic shoes (with flexible rubber soles) retained more fine sand and silt-sized particles than did the work boots (with hard rubber soles).

The successful differential sampling of particles adhering to footwear surfaces enables the comparison of particle populations that adhere with different tenacities, allowing the development and exploitation of methods that can recognize different particle signals occurring simultaneously on these surfaces. Differential sampling also allows more fundamental investigations of phenomena contributing to the transfer and persistence of small particles on footwear.

This project was supported in part by an award from the National Institute of Justice, Office of Justice Programs, United States Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect those of the Department of Justice.

Reference(s):

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Trace Evidence, Footwear, Particle Signals