B22 Method to Determine Collection Efficiency of Particles by Swipe Sampling

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After attending this presentation, attendees will understand alternative methods of particle collection for trace analysis, compared to tape pulls or vacuum collection. Various sample surfaces, particle sizes, and ideal collection traps will be discussed.

This presentation will impact the forensic community and/or humanity by suggesting alternative ways to collect trace evidence as compared to tape pulls and vacuum collection, along with the ideal surfaces from which to collect trace particles.

A methodology was developed to evaluate particle collection efficiencies from swipe sampling of trace residues. Swipe sampling is used for many applications where trace residues must be collected, including the evaluation of radioactive particle contamination and the analysis of explosives and contraband at screening checkpoints using Ion Mobility Spectrometry (IMS), along with Gas Chromatography-Mass Spectrometry (GC-MS), High Performance Liquid Chromatography (HPLC), and other analytical tools. Collection efficiencies were evaluated for micrometer-sized polystyrene latex (PSL) spheres with respect to particle size and mode of deposition, collection trap, surface type, and swiping force. The types of surfaces sampled in explosives screening environments include the exteriors and interiors of carry-on luggage, laptop computers, upholstery, clothing, etc. Four test surfaces were selected to represent some of the target surfaces at screening venues in airports. These include: 1) a textured vinyl, 2) a smooth vinyl, 3) a stiff cotton fabric, and 4) a thin nylon fabric. Collection traps used included a woven cotton cloth (muslin), a polytetrafluoroethylene (PTFE, also known as Teflon)-coated woven fiberglass trap, and Swiffer Sweeper® dry cloths. Although particles are likely to be non-spherical, and can be expected to be in a heterogeneous matrix containing the sebaceous materials (body oils) common to latent fingerprints, the use of spherical particles was chosen because of the ability to control particle size and to simplify particle counting (through use of a fluorescent tag). The particles are deposited in two ways, either dry, or in a matrix of sebaceous material. Test surfaces containing particles were prepared under controlled conditions and swiped with a reproducible technique that allows for the evaluation of frictional forces. Collection efficiencies were determined by optical imaging and particle counting.

Of the two IMS collection traps studied, the PTFE trap has significantly lower collection efficiencies. This is likely to be due to a combination of texture and composition. The larger (42 um) particles are collected more efficiently than the smaller (9 um) particles. Particles in a matrix similar to latent fingerprints are collected more efficiently than dry particles. Applying greater normal force during swiping does not greatly improve collection efficiencies. This fact, coupled with the observation that many particles are detached but not collected, implies that improvements in collection efficiency are dependent on improvements in adhesion of the particles to the collection surface, rather than larger forces to detach the particles. This is supported by the fact that particles embedded in sebum, which is a sticky matrix, are collected more efficiently than the dry particles. A lack of adhesion of the particles to the collection surface may also explain the poor collection efficiency of the PTFE trap. Overall, the highest collection efficiencies are observed for the largest particles (42 um) embedded in sebum collected with the muslin trap. Under these conditions, close to 100 % collection efficiencies can be achieved from three of the four test surfaces. The cotton canvas surface is not amenable to swiping with the two traps studied. The collection efficiencies are routinely poor for this surface, probably due to trapping of the particles in the weave of the fabric during swiping.

Ion Mobility Spectrometry, Trace Analysis, Particle Collection

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