B147 Microtrace to Nanotrace: Extracting Information at Increasingly Smaller Length Scales

Christopher S. Palenik, PhD, Microtrace, 790 Fletcher Drive, Ste 106, Elgin, IL 60123-4755; and Skip Palenik, BS*, Microtrace, 790 Fletcher Drive, Ste 106, Elgin, IL 60123-4755*

After attending this presentation, attendees will understand that presently the majority of trace evidence examinations focus on features and particles larger than 10 micrometers in size. Highly engineered and naturally occurring particles in the low micrometer- to nanometer-size range surround us and are seeing more use each year.

This presentation will impact the forensic science community by providing a primer to the forensic science community on the potential value, analytical approaches, and concerns that must be addressed when approaching particles at this length scale.

In the spirit of this year's conference theme, "Celebrating the Forensic Science Family," this double-feature, father-son presentation will discuss the benefits, significance, and, ultimately, the need to find and extract information from increasingly smaller amounts of trace evidence. Presented from two perspectives, one couched in the rich history of forensic science and its founders, the other taken from the exciting potential in new and higher-resolution methods, both authors arrive at common ground in recognizing the importance of visual evidence as seen through the microscope.

For more than a century, scientists have exploited the value of small particles through trace evidence. While hardly a novel concept in itself, three factors have caused us to explore and consider its significance in terms of increasingly smaller features and particles in the context of trace evidence. The first is a consequence of the *CSI*-effect. Savvy criminals are often aware of trace evidence and, in some instances, make active efforts to minimize these contacts. Secondly, as society enters the age of nanotechnology, highly engineered particles, layers, and features of materials are becoming increasingly smaller while, at the same time, becoming more complex. As paint layers reach the sub-10 micrometer range, multilayer film layers reach the nanometer scale, and free nanoparticles begin to find regular commercial use in a wide range of consumer products such as cosmetics, glass, fibers, and paint. Finally, robust and practical microanalytical methods of light and electron microscopy combined with vibrational micro-spectroscopy provide the means by which these particles and features can be detected, identified, and compared.

The practical task then becomes searching for such particles and features, finding them, and finally conclusively identifying them. This is hardly trivial given their size, which may be unresolvable by stereomicroscopy alone. For example, microspheres of silica, used in many cosmetic formulations, are only a few 10s of micrometers in size. While not resolvable by stereomicroscopy, these isotropic spheres could be mistaken for an immiscible phase in a microscope slide preparation. Once found and recognized, they must be characterized to extract specific information about size, composition, and nano-morphology. Finally, the new questions of contamination, source, and significance arise in this new realm of materials. For example: Is this layer really a layer? When was this population of nanoparticles introduced? What is the potential for transfer? New, or at least more, vigilant checks for cross-contamination must be considered when working at these length-scales.

While some materials and the feature sizes are novel, the approach is in many ways a continuum of current practices, simply modified to work at increasingly higher resolutions. This presentation will explore the practical application of the approach discussed above through various casework examples from the realms of paint, fibers, cosmetics, dust, and soils to illustrate considerations relevant to the exploitation of increasingly smaller scales of trace evidence.

Ultimately, this study suggests that many existing methods common to most trace evidence laboratories can be better utilized to approach these smaller particles and features while other technologies in microanalysis are becoming (or have become) practical for application to this new realm of trace evidence.

Nanotrace, Microscopy, Trace Evidence