C22 Forensic Applications of the Transmission Electron Microscope

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The goal of this presentation is to present to the forensic community information about how Transmission Electron Microscopy (TEM) can be instrumental in forensic trace evidence analyses.

This presentation will impact the forensic science community by showing how TEM can be very useful in forensic trace evidence analysis due to its ability to analyze the morphology of small particles, gather elemental information on very small particles and determine the internal structure of small particles. This presentation will show the advantages of using TEM along with other microscopic techniques to characterize and identify particles, specifically nanoparticles, for forensic purposes.

TEM is rarely used as an analytical tool in forensic science. However, it can be very useful in this area because of its ability to analyze the morphology of small particles, gather elemental composition information on very small particles because of its beam concentration ability, and determine the internal structure of particles, whether crystalline or amorphous, via electron diffraction.

In a recent environmental forensic case study, there was a stain on the window of a building painted with an off-white architectural paint. There was a question of whether this stain was caused by the architectural paint it- self or the caulk around the window. Scanning Electron Microscopy (SEM) and Polarized Light Microscopy (PLM) were used to characterize the con- stituents of the paint, caulk and stain to determine if the stain was caused by either the caulk or the paint. SEM and PLM observed 4 different constituents of the paint. By using TEM, the 4 components previously analyzed using the other methods, but also thin iron fibers, not detected by SEM or PLM, within the paint and the stain were observed. It can be concluded, using TEM, that the architectural paint was indeed the source of the stain on the window.

The production and application of nanoparticles continues to increase significantly. Therefore, it is very important to characterize these particles in order to study their impact on trace evidence examinations. Some nanopar- ticles that have become of significant interest are “fullerenes”. Fullerenes are a 3rd carbon allotrope, along with diamond and graphite, with many unique properties that increase their potential use in various products. These prod- ucts include clothes, concrete, sports equipment, water filters, lubricators, fuels and batteries, to name a few. The use of fullerenes in these products can eventually lead to their existence in trace evidence samples. For that reason, TEM was used to characterize some of the fullerenes and other nanoparticles because of its ability to analyze very small particles that aren’t easily analyzed using other microscopical techniques. These fullerenes include; carbon 60 (C60), also referred to as “bucky balls”, which are closed caged molecules, about 1nm in diameter, with 60 carbon atoms; carbon 70 (C70), which are also bucky balls with 70 carbon atoms; single-walled carbon nanotubes, which are elongated fullerenes with an average diameter of 1.2nm; and double-walled carbon nanotubes, which are also elongated fullerenes with varying nanometer range diameters. Other nanoparticles that I’ve characterized by TEM because of their potential importance to forensic trace evidence analyses are aciniform soot, carbon black, fumed silica, silicon carbide, aluminum nanospheres, fumed alumina, aciniform tantalum, acini- form nickel, fly ash, welding fumes, gunshot residue, and paint pigments and fillers. Present research also involves using TEM to develop a nanopar- ticle database that provides a reference comparable to other nanoparticles potentially observed during future trace evidence examinations. Using TEM in forensic science trace evidence examinations can augment other analysis tools by gathering morphological, elemental and internal structure informa- tion on very small particles that may be overlooked or not easily analyzed using other microscopical techniques.

TEM, Fullerenes, Trace Evidence Analysis

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