D7 Environmental Forensic Microscopy of Particles

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Learning Overview: After attending this presentation, attendees will understand how the use of environmental forensic microscopy of particles can be used to identify particles in various dusts and help determine their provenance.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating how environmental forensic microscopy can be used to determine the identity of the particles found in various dusts and comparing the analytical results with information obtained from a number of sources.

Accumulated information from more than 40 years of analyses of dust particles from residential homes, office buildings, and outdoor areas provides the ability to draw useful comparisons between what may be called "normal" dusts and dusts that occur in specialty facilities, such as computer centers, or those dusts that resulted from man-made and natural catastrophic events, such as the 9/11 World Trade Center (WTC) disaster and wildfires.

Analyses were performed on 72 samples of dust collected from homes in seven geographically diverse metropolitan areas in the United States. The analysts used a stereomicroscope, Polarized Light Microscopy (PLM), Scanning Electron Microscopy (SEM) that included Energy Dispersive X-ray Spectroscopy (EDS) elemental analysis, Transmission Electron Microscopy (TEM) that included EDS and Selected Area Electron Diffraction (SAED), and Fourier Transform Infrared (FTIR) microscopy as necessary. Over 90% of the samples contained the following common components: skin cells, soil minerals, plant fragments, hair, cotton fibers, and starch granules. In addition to the 72-sample study, hundreds of other samples of residential and office dusts have been examined from the United States. Components often found in these samples included those found in the 72-sample study and also included: wool fibers, pollen, fungal material, soot, synthetic fibers, glass fibers, paper fragments, ink/photocopy particles, construction debris, insect parts, rust/metal flakes, and aerosol particles (such as hair spray). The types of particles in residential and office dusts were also influenced by the proximity to certain industrial processes (such as spherical glassy particles of fly ash from coal-fired power plants and metallic spheres from some incineration facilities).

A sample of dust collected from a computer facility showed many components similar to residential and office dust but also contained zinc whiskers. Zinc whiskers form tiny conductive filaments in the presence of electromagnetic fields on steel surfaces that have been plated with zinc (galvanized) for corrosion protection.

The general composition of WTC dust was found to be primarily mineral wool (glass), gypsum, cement and calcium particles, cellulose, soot and char, silica, <1%–2% asbestos, less than 1% paint (some of it lead paint), metal, vermiculite flakes, and glass shards. Microscopic spherical iron particles generated from high-temperature, torch-cutting efforts that were performed during the rescue efforts were also found.

As expected, the dusts from homes affected by the particles produced by a wildfire contained higher levels of burnt materials, both black carbon soot and char. In some instances, electron microscopy was able to distinguish between the aciniform (appearance of a bunch of grapes) black carbon soot of the fire and aciniform-engineered carbon black.

Microscope, Dust, Particulate