C3 Combustible Dusts and Dusts From Combustion

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After attending this presentation, attendees will understand how to identify combustible dusts and particles generated by combustion using microscopy tests.

This presentation will impact the forensic science community by providing information about combustible dusts that is an important safety concern for investigators entering dusty areas and useful forensic data in the study of explosions, fires, and sooty particulate.

When forensic investigators enter an enclosed area in a dusty building, they must be aware of the potential for a combustible dust explosion. The Occupational Safety and Health Administration (OSHA) provides a convenient poster that lists 116 combustible dusts divided into six categories: agricultural products (including corn starch), agricultural dusts (including garlic powder and raw yucca seed dust), carbonaceous dusts (including petroleum coke and pine soot), chemical dusts (including ascorbic acid and sodium stearate), metal dusts (including aluminum and iron carbonyl), and plastic dusts (including acrylonitile and epoxy resin).[1] The identification of an unknown dust as one of the OSHA 116 can usually be done by an experienced analyst with one of two microscopy tests. The shape, appearance, and optical properties as determined by Polarized Light Microscopy (PLM) are sufficient to identify many of the agricultural powders. The X-ray elemental analysis performed in the Scanning Electron Microscope (SEM-EDS) can determine which metal dust is present and the Fourier Transform Infrared Microspectrophotometry (FTIR) and Raman microscopy are capable of identifying the plastic dusts. Combinations of the four microscopy techniques (PLM, FTIR, Raman, and SEM-EDS) are used to identify the carbonaceous and chemical dusts. The identification of combustible dusts is important for both the safety of the investigators on-site and for the forensic experts reconstructing explosive or fire events.

Spontaneous combustion of agricultural materials can occur when bacteria slowly decompose the materials, producing heat. When the internal temperature reaches 185°F (85°C), hot spots and pockets may be expected. Flames will likely develop when these pockets come in contact with the air. Non-biological mechanisms may be involved with non-agricultural dusts. Pyrite oxidation has been reported as a cause of spontaneous ignition in old coal mine tailings.

After dusts have burned, microscopy tools are also used to characterize and identify the combustion products. Char particles, a product of partial combustion or a low-temperature situation, retain morphological characteristics of the original dust particles. Aciniform soot and flyash are the products of higher temperature combustion where the chemical elements of the original dust particles have reformed after being vaporized. The combination of a clear tape lift attached to a glass microscope slide and a wipe sampler is the preferred collection media set for soot testing. The clear tape lifts by themselves are helpful for screening purposes, especially to identify mold, biofilm, or other biological growth, but it is difficult to remove the particulate for other testing when a fuller analysis is in order. For instance, the finding by light microscopy of dark, opaque, aggregated particles on a tape lift suggest aciniform soot may be present, but this can only be confirmed with transmission electron microscopy as the diameters of the primary carbon particles in aciniform soot may be in the 30 – 40 nanometer range. The ASTM Standard D6602 is a method for identifying carbon black, an engineered aciniform carbon soot, that can be used to identify combustion dust particles in a variety of settings.[2]

References:

1. www.osha.gov/Publications/combustibledustposter.pdf (last accessed on 7/24/2012).
2. ASTM D6602 - 03b(2010)e1 Standard Practice for Sampling and Testing of Possible Carbon Black Fugitive Emissions or Other Environmental Particulate, or Both. ASTM International, West Conshohocken, PA, 19428-2959 USA

Explosive Dust, Soot, ASTM D6602

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