Criminalistics Section - 2016

B47 Characterization of Aluminum (Al) Powders in Explosives Utilizing Particle Micromorphometry

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After attending this presentation, attendees will better understand the forensic potential of automated particle micromorphometry to aid in making comparisons between questioned and known Al powders. In addition, the results from this study may help provide insight into the method of Al powder manufacturing.

This presentation will impact the forensic science community by demonstrating the application of aluminum particle micromorphometry as a quantitative method for the characterization and comparison of explosive evidence, which may also provide valuable lead identification for forensic investigations.

Al powders have a wide variety of legitimate uses, are widely available without significant regulatory constraints, and are commonly used in pyrotechnics and explosives as a fuel to increase the heat of explosion.[1,2] Al powders can be bought from manufacturers or can be made inexpensively at home using basic instructional manuals and videos.[3] Due to their ease of production, bomb-makers commonly mix Al powder with ammonium nitrate or RDX to gain larger detonations for the construction of Improvised Explosive Devices (IEDs).[3,4] Al particle size and shape influence how reactive the Al powder will be; smaller particle size and flatter particle shapes will lead to a higher reactivity.[1] This research investigates the potential of using particle micromorphometry to differentiate Al powders, with the goal of comparing Al samples (e.g., known versus unknown source samples) as well as provide insights into production methods.

This presentation builds on the results from a small pilot study that determined that differences in manufacturing methods of Al powder produced differences in particle micromorphometry. A significantly larger-scale study (greater number and variety of samples with more detailed sample pedigrees) is currently being performed. Al powder samples were obtained from legitimate industrial manufacturers, seized IEDs, and "in-house" production from Al flake-containing commercial spray paint and ground Al foil. To replicate amateur methods of Al powder production, Al foil was ground in a consumer-grade blender as well as in a small 6lb rotary dual-drum ball mill. To obtain uniform particle size for high-quality microscopical imaging, the Al powder samples were wet-sieved with disposable polyester mesh. Transmitted light microscope images (*n*1,600 images/sample) of the Al samples were acquired using an automated stage. Dimensional analysis was calibrated using a National Institute of Standards and Technology (NIST) -traceable stage micrometer; polystyrene spheres of 100µm, 50µm, and 10µm were used as secondary standards to assess linear calibration. Images were batch processed using commercial image analysis software and customized code. Each image was pre-filtered using a high-pass filter to enhance edge detection and converted to a binary image. Seventeen parameters were measured for each particle within the image field of view including: area, aspect ratio, perimeter, roundness, mean diameter, mean feret, radii (maximum and minimum distance from particle centroid to edge), radius ratio, box height, box width, and fractal dimension. The large multidimensional datasets (*n*90,000-210,000 particles/sample) were analyzed using an open-source statistical package; the results from the multivariate statistical methods will be presented. Initial statistical results from the pilot study, which included only 23 Al powders, showed classification success rates ranging from 81%-94%, depending on particle size range.

Reference(s):

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3. Larabee A. 2015. The Wrong Hands: Popular Weapons Manuals and Their Historic Challenges to a Democratic Society. Oxford University Press New York, New York.
4. Kuznetsov A.V., Osetrov, O.I. 2006. Detection of improvised explosives (IE) and explosive devices (IED). In Schubert H., Kuznetsov A., (eds) *Detection and Disposal of Improvised Explosives*, pgs. 7-25. Springer-Netherlands.

Aluminum Powder, Particle Micromorphometry, Automated Stage Analysis

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