B78 Assessing the Forensic Potential of Small Arms Propellant Micromorphometry as an Aid in the Investigation of Improvised Explosive Devices (IEDs): A Pilot Study

Jack Hietpas, PhD, 1617 Courthouse Road, Stafford, VA 22554-5409; and Peter J. Diaczuk, BS, 445 W 59th Street, New York, NY 10019-2925*

After attending this presentation, participants will have a better understanding of the strengths and limitations of morphometry as a method for the characterization and discrimination of small arms propellants.

This presentation will impact the forensic science community by demonstrating the application of automated image analysis for the measurement of small arms morphometry as a quantitative method for the characterization of explosives.

Pipe bombs are the most common IED in the United States, with the majority containing small arms propellant (Smokeless Powder (SP) and Black Powder (BP)) as the main explosive charge.[1] In addition, United States and coalition war fighters combat IEDs at an unprecedented scale.[2] Thus there is a need to develop robust metrics for the characterization of propellants that are used as explosives as well as for comparisons between exemplar and recovered explosive residues. SP micrometry (length and width measurements) has been shown to help reduce the number of possible manufactured brands, thus providing fast, valuable investigative information.[1]

In this pilot study, the potential to use automated image analysis software to characterize small arms propellants was investigated. Approximately 50 samples of SP and BP were acquired. These samples consist of eight propellant distributors and span 37 brands. In addition, there are several sample brand replicates that have either different production dates or different distributors. For each sample, at least 100 kernels of powder were placed on transparent adhesive backings. Transmitted light was used to produce high-contrast "masks" of the individual kernels. Photomicrographs were captured at 10-30x magnification using stereomicroscopy. Open-source image analysis software was used to process the propellant kernel images, thus allowing thousands of particles to be quickly characterized. The following parameters were measured for all the particles in each captured image: area, perimeter, major and minor axis of best fit ellipse, circularity, porosity, aspect ratio, and solidity. Canonical Discriminant Analysis (CDA) was used to separate the sample classes. These classes were treated as a database of known standards. Next, an independent set of particles was processed (from the original stock propellant samples). These were treated as "unknown" samples. These "unknowns" were assigned to the class (database entry) that had the smallest Mahalanobis distance. Seven samples were incorrectly assigned to the specific database entry; however, two of these were simply assigned to replicate entries (same brand, different lot or distributor). In addition, two of the incorrect samples were assigned to database entries that have been reported to be the same propellant but sold under different brand names. The remaining three samples were truly incorrect assignments. The results from this study show that there is potential for using automated image analysis for the characterization of small arms propellants. By using automated methods, the time required for particle measurements is dramatically reduced in comparison to manual methods.

References:

1. Moorehead, W. Characterization of smokeless powders. In: Blackledge, RD, editor. *Forensic Analysis on the Cutting Edge*. Wiley-Interscience, 2007:241-268.
2. Countering Improvised Explosive Devices, 2013. http://www.whitehouse.gov/sites/default/files/docs/cied_1.pdf

Image Analysis, Smokeless Powders, Explosives