A88 Laser Induced Breakdown Spectroscopy (LIBS): Characterization of Bullets, Gunshot Residue, and Bullet Wipe

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After attending this presentation, attendees will have a basic understanding of Laser Induced Breakdown Spectroscopy (LIBS), the effects that distance has on the detection of gunshot residue and bullet wipe on clothing, cement block, wood, and drywall, and the general trends to observe when applying LIBS to the analysis of bullet fragments and bullet holes.

This presentation will impact the forensic science community by introducing LIBS as a presumptive test for the identification of bullet fragments, gunshot residue (GSR) and bullet wipe. It will demonstrate that LIBS, in comparison to established chemical testing, will be more useful in the detection of bullet wipe in the absence of GSR. The techniques developed in this project will have the potential to establish an area of bullet impact detection in the presence and absence of gunshot residue.

Laser Induced Breakdown Spectroscopy (LIBS) can be used to quickly determine the elemental composition of gas, liquid, and solid samples with minimal sample preparation. A LIBS instrument commonly incorporates a ND: Yag Laser and a CCD or Eschelle detector. The laser pulse ablates material from a sample, producing high temperature plasma. The plasma emits light at wavelengths that are characteristic of the elements ablated from the sample. The emission of the plasma is collected and analyzed by a detector within the LIBS system. The advantages of LIBS are that the method is relatively non-destructive, very little sample preparation is required, and the spectra can be obtained instantaneously. The disadvantages are that the limit of detection is presently only 4-10 ppm and the percent composition of trace elements cannot be determined to the level of accuracy required for forensic analyses. However, as shown by this project, LIBS can be used as a quick test when the presence of specific elements can be used to identify a sample; lead (Pb) for a bullet fragment or lead (Pb) and barium (Ba) for a suspected bullet hole.

Gunshot residue can serve as a vital form of circumstantial evidence in crime scene investigations. Cases involving the use of firearms, traces of lead (Pb), barium (Ba), and antimony (Sb) can be detected on the victim, criminal, and other objects that have come in contact with the firearm and or fired projectiles. However, when the point of impact is

more than three feet from the source of the gunshot, the GSR becomes less visible and the only detectable trace is a dark ring of lead or barrel residue formed from the bullet (lead or full metal jacketed) at the site of impact as it passes through the material. This is classified as bullet wipe in the firearms field. LIBS can be used to identify lead (Pb) and barium (Ba), the elemental components of bullet wipe and bullet fragments. This instrumentation has the potential to become an important tool in the analysis of trace evidence.

The LIBS System has been used to analyze four unfired bullets and a variety of materials shot from a range of one inch to twelve feet. Peaks at 280.16, 368.49, and 405nm indicated a positive test for lead and at 455.4, 493.4, and 553.5 nm for barium. The analysis of spectra for materials from a T-shirt with simple spectra and few elements will be compared to cement block, a more complicated material composed of several different minerals and numerous inorganic elements.

Laser Induced Breakdown Spectroscopy, Gunshot Residue, Bullet

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