A205 Standardized Chemical Characterization of Glass by Laser Induced Breakdown Spectroscopy (LIBS)

Erica M. Cahoon, BS, Florida International University, University Park, CP 194, 11200 Southwest 8th Street, Miami, FL 33199; and Jose R. Almirall, PhD, Department of Chemistry, Florida International University, University Park, Miami, FL 33199*

After attending this presentation, attendees will have learned how chemical analysis and comparison of glass evidence by using commercially available LIBS instrumentation can provide information useful to forensic scientists.

This presentation will impact the forensic science community by demonstrating that LIBS is a viable alternative to the forensic examination of glass.

Glass is a commonly encountered type of trace evidence found at many crime scenes. Glass fragments can provide forensic investigators valuable information of association between items of evidence and potentially link a suspect to the scene of a crime. Much of the population of glass made for the same end use exhibits a similar elemental composition and therefore the value of information derived from chemical analysis will depend on the discrimination (or informing) power of the techniques used for its characterization. There is a range of techniques available for the forensic examination of glass with Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) considered as the "gold standard" for the elemental analysis of glass. This method; however, requires very expensive instrumentation, elaborate facilities to house the equipment and a high level of operator sophistication, therefore less than 10 such instrumental setups are installed in forensic laboratories in the U.S. The use of micro X-ray Fluorescence (μ-XRF) for forensic analysis of materials is more popular in forensic laboratories but this technique suffers from disadvantages such as dependence on sample geometry, time required for analysis and the limitation of qualitative analysis (vs true quantitative analysis for LA- ICP-MS). Laser induced breakdown spectroscopy (LIBS) has emerged as a viable atomic spectroscopy alternative to both LA-ICP-MS and μ-XRF. LIBS has been shown to provide for fast multi-element chemical analyses that provides very similar informing power (discrimination) to LA-ICP- MS and μ-XRF, for a fraction of the cost while offering many advantages over these methods. With a sensitivity of approximately 10-100 mg/Kg (ppm) for most elements of interest in the glass matrix, LIBS is able to chemically characterize the sample quickly and provides the potential for straightforward data analysis.

To date, researchers who have reported good discrimination power and type I and type II errors have used LIBS instrumentation built for the research environment, making the technique not yet practical for the operational forensic laboratory. This presentation describes, for the first time, an approach that incorporates a robust commercial LIBS instrument that can be used for the chemical characterization of glass in the forensic laboratory. The results presented were acquired using an RT100-HP LIBS system using a Q-switched Nd:YAG laser operating at the fundamental wavelength and equipped with a high resolution spectrometer coupled to an ICCD detector. Parameters such as the acquisition gate delay, gate width, and number of laser pulses were varied to optimize the signal-to-noise and signal-to-continuum performance of the instrument. The spectra were optimally collected as a result of 100 laser shots with the accumulation of the last 50 shots used to generate the spectra for analysis. Each glass sampled was analyzed at five locations to

account for any heterogeneity. NIST glass standards 614, 610, 612, 1831 and Bundeskriminalamt (BKA) glass reference standards FGS 01 and FGS 02 were used for the development of the analytical protocols and to determine the precision, accuracy and repeatability of the LIBS analysis. A set of 41 vehicle glass samples and 32 container glass samples from different sources were analyzed with the optimized method and all samples were compared to each other to determine discrimination power, type I and type II error rates. The discriminating elemental emission lines used were Sr, Fe, Ca, Mg, Ti, Ba, K, Al, and Na. The presentation will also report how this instrumentation can find use in other areas of trace evidence characterization within the forensic laboratory.

LIBS, Glass, Chemical Characterization

 ** Presenting Author*