B103 Laser Induced Breakdown Spectroscopy (LIBS) and X-ray Fluorescence (XRF) Analyses of Biological Matrices

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After attending this presentation, attendees will learn how elemental analysis by LIBS and XRF can provide important information about the elemental analysis of biological matrices.

This presentation will impact the forensic community by demonstrating how qualitative and quantitative analysis of the elemental distributions in hair, nail, and bone samples may play a significant role in revealing key information in various types of forensic investigations including provenancing of human remains, monitoring of environmental exposures to metals, and detection of intentional poisoning with heavy metals. Elemental profiling of biological matrices has been accomplished using Laser-Induced Breakdown Spectroscopy (LIBS) and X-Ray Fluorescence (XRF).

Elemental profiling of biological matrices has been accomplished using Laser-Induced Breakdown Spectroscopy (LIBS) and X-Ray Fluorescence (XRF). Qualitative and quantitative analysis of the elemental distributions in hair, nail and bone samples may play a significant role in revealing key information in various types of forensic investigations including provenancing of human remains, monitoring of environmental exposures to metals and detection of intentional poisoning with heavy metals.

Methods for the quantitative and qualitative analysis of hair, nail, and bone samples were developed by using both LIBS and XRF analyses. Certified NIST standards for bone, hair, and fingernail were used in the development of the analytical protocols and to determine the precision, accuracy and repeatability of the LIBS and XRF analysis. The LIBS instrumentation consisted of a single pulsed Continuum 1064 nm excitation wavelength laser and an Andor intensified CCD detector with an optical delivery system designed and built in our laboratory. Double pulse LIBS experiments provided improved precision and sensitivity to the target emission lines of the elements of interest and included combinations of the 1064, 532 and 266 nm wavelengths as excitation sources. The XRF instrumentation consisted of an IXRF Mo tube operated at 50KV with a 50 um beam installed in a FEI SEM microscope equipped with an EDAX Energy Dispersive Detector (EDS) detector. Elemental mapping of the matrices was possible with the SEM-EDS while elemental analysis was improved using the XRF (with an EDS detector). The element menu previously determined to provide good discrimination by LA-ICP-MS by other workers in our group was used as a starting point in the method development for this study. The elements of interest in the bone provenancing work, for example was: Ca, Al, Mg, Fe, Mn, Ba, Pb, Rb, Sr, and Y. Calibration curves were constructed for the quantitation of these metals by varying concentrations of standards in graphite pellets and spiked resins. The results obtained by LIBS and XRF were compared to the competing technique of Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS). LA-ICP-MS has already been shown to provide excellent sensitivity and accuracy, but this technique is very complex and expensive to use and may be out of range for the typical forensic laboratory. The incorporation of LIBS and/or XRF may provide a viable alternative to the more complex LA-ICP-MS technique at a fraction of the price.

LIBS and XRF methods were developed for elemental analysis of bone, nail and hair standards and these two methods were applied in the analysis of a small set of bone samples from nine different individuals to determine if the individuals could be differentiated. The XRF and LIBS results were compared to the already established LA-ICP-MS method results. The XRF and LIBS methods offer the advantages of lower cost, ease of use, similar precision and accuracy and good sensitivity for the elements of interest for the characterization of these matrices.

LIBS, XRF, Bone

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