B106 Elemental Analysis of Materials by Laser Ablation Inductively Coupled Plasma (LAICP-MS) for Forensic Applications; Instrumental Considerations

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This presentation will cover the instrumental considerations associated with the analysis of trace amounts of metals in materials such as differences between sample introduction systems, mass spectrometers and available options.

This presentation will facilitate a better understanding of the use of the different sample introductions systems into an ICP-MS. The presentation will also cover the selection of spectrometer types for the purpose of trace elemental analysis, including the use of TOF, quadrupole and magnetic sector instruments. An analysis of the dynamic reaction cell technology as applied to forensic analysis, is also presented.

The elemental analysis of materials has become an important yet underutilized type of evidence at many crime scenes. Although the utility of trace elemental analyses and comparisons for glass or paint fragments has been shown to offer a high degree of discrimination between different sources of these materials, the lack of method development, validation of methods and publication of results in the open literature have limited the adoption of this technology by the typical forensic laboratory. Additional barriers include the expense of the equipment and the sophistication required for its operation.

This presentation will focus on presenting the commercially available options for the elemental analysis of materials such as glass using ICP-MS, the most sensitive and practical of the elemental analysis methods available to the forensic scientist. Forensic examiners have the option to analyze glass by dissolution (digestion) or, by using a solid sample introduction system (laser ablation). The advantages and disadvantages of each of these choices are presented. Forensic examiners then have the option of selecting the type of mass spectrometer as the detector. Time of Flight (TOF), quadrupole and magnetic sector instruments are available. Speed of analysis, resolution and cost considerations will determine the instrument of choice and these factors are discussed. Within the quadrupole class of mass spectrometers, new collision cell accessories are now available in order to reduce the interferences that often plague unit resolution devices.

While solution analysis does not require the additional purchase of a laser ablation system, significant disadvantages related to the digestion of glass samples leads one to conclude that the added expense of the solid sampling introduction system is worthwhile. A direct comparison of solution data with LA-ICP-MS data for a variety of glass sample types is presented. A direct comparison of the data generated using the different mass spectrometer detectors is also presented. Finally, a study to determine the utility of a dynamic reaction cell using a Perkin Elmer DRCII mass spectrometer as compared to the use of an Agilent 4500 plus mass spectrometer is also presented. The most significant advantage to the addition of dynamic reaction cell technology is the potential for the elimination of polyatomic ion interferences for Se, As, Fe, K, Cr, Mn and Cu upon detection.

A direct comparison between two laser systems (CETAC LSX 200 plus and the CETAC LSX 500) when used for materials analysis is also presented. The LSX 500 offers better limits of detection and precision (<5% RSD) due to the increased power of the laser and the flat beam profile, both of which lead to better laser/material interaction. Scanning Electron Microscopy (SEM) imaging was also conducted in order to evaluate physical characteristics of the craters left by the laser in the glass fragments. A JSM-5900-LV JEOL SEM operated at high vacuum, using secondary electron imaging at 20 KV was used to image craters of a spot size of ~ 40µm. The glass samples were coated with gold to prevent charging.

Elemental Analysis, LA-ICP-MS, Materials Analysis

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