B133 Evaluation of Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS) as a Tool for the Elemental Analysis and Discrimination of Glass Evidence

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The goals of this presentation are to present to the forensic community the discrimination power of Laser Ablation as a direct sample introduction technique in the elemental analysis of glass samples by ICP-MS.

Glass is a common type of evidence encountered in crimes such as burglary, car accidents, vandalism, and kidnapping. Elemental analysis by ICP-MS has provided a high degree of discrimination between glass fragments. However, typical sampling introduction methods require time consuming and complicated sample preparation steps to bring the sample into solution and subsequent analysis.

LA-ICP-MS is a modification of ICP-MS in which a laser is used for initial sample volatilization and direct introduction of solids into the plasma. Recent developments in this technique have demonstrated its potential for rapid and simplified microanalysis of the major, minor, and trace elements in solid materials.

The aim of this presentation is to evaluate the discriminating value of the laser ablation sample introduction technique in comparison with well-studied solution ICP-MS methods.

Two laser ablation systems both with a wavelength of 266nm but with different nominal energy density output energies were used during this study. In order to optimize the sample introduction into the plasma, laser parameters such as spot size, carrier gas, ablation frequency, laser power, acquisition, and ablation mode were optimized for glasses of forensic interest.

The elemental composition was quantitatively determined using internal standardization with the isotope Si^{29} and using a one-point calibration with the reference material NIST SRM 612. The reference glasses SRM 1831 and SRM 1411 were used as control standards to evaluate the accuracy and precision within the analysis.

Different types of glasses that are commonly found in crime scenes were evaluated. One set of forty-five headlamps samples was characterized by elemental analysis using 20 elements and 14 elemental ratios. A second set of 46 automotive glasses was also characterized using 12 elemental ratios composed of 20 elements. The 45 samples consisted in 34 lens and 11 reflectors and the auto windows set contained both windshield and side window glasses.

The relative discrimination power of refractive index, LA-ICP-MS, and their combinations, using pairwise comparisons and statistical tests are also presented. From the pairwise comparisons, the relative discrimination power of each elemental ratio with ICP-MS was determined. The number of indistinguishable pairs arising from RI and LA-ICP-MS provides a means of evaluating the relative strength of each technique, as well as its comparison with previously reported results for external calibration and isotope dilution techniques.

In LA-ICP-MS, the elimination of the digestion and solution step not only reduces the cost of high quality reagents (trace quality) and standards but also eliminates the risk of use hazard materials, such as HF, in the digestion procedure. Another important advantage that LA presented is that it is a relatively non-destructive technique and small fragments (as small as 100*n*m) may be easily analyzed. Laser ablation also significantly reduces the time of sample preparation by as much as 75%. Finally, the laser ablation technique has shown to provide very low detection limits for absolute mass measurements of metals of interest to forensic scientists permitting the quantitative analysis of femtograms of the metal analytes analyzed from craters as small as 50 microns in diameter and 70 microns deep.

The simpler, faster and less intrusive sample introduction method of LA-ICP-MS provides similar discrimination power to the conventional nebulization techniques for aqueous samples and is a viable and alternative to the solution methods of elemental analysis.

Laser Ablation, Elemental Analysis, Glass

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