B164 Laser Ablation Inductively Coupled Plasma Mass Spectrometry of Forensic Glass Samples

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After attending this presentation, attendees will have been presented with laser ablation-inductively coupled plasma-mass spectrometry as a technique to differentiate glass samples with similar optical and physical properties.

The results from this study will demonstrate that LA-ICP-MS is a fast, accurate, and reliable technique that provides a high level of discrimination in the analysis of glass fragments that cannot be differentiated by other techniques.

This paper will evaluate laser ablation-inductively coupled plasmamass spectrometry (LA-ICPMS) as a technique to determine the unique trace elemental signature or fingerprint of glass samples for discrimination, and present criteria and protocols for the comparison and differentiation of glass fragments from different sources by LA-ICP-MS. Characterization of glass fragments is normally accomplished by measuring the physical and optical properties of density and refractive index. However further discrimination, such as identification of a suspected source of origin, has become more difficult as the range of refractive indices has narrowed within glass subtypes because of
advances in glass manufacturing technology.

LA-ICP-MS provides a means for the forensic examiner to assign a probability for positive association of a questioned glass sample based on its trace elemental composition. Knowing trace element concentrations improves the confidence of a match and strengthens the value of evidence presented in court. ICP-MS provides a high level of discrimination for glass samples due to excellent detection limits (10-100 times better than ICP-atomic emission spectroscopy), wide element range coverage, and isotopic information. LA-ICP-MS is rapid, eliminates the need for extensive sample preparation, and is virtually a nondestructive technique, allowing for the possibility of further analysis of questioned samples by corroborative techniques. Furthermore, LA promises to increase the number of analytically useful elements by eliminating problems with some elements due to poor dissolution and contamination. Additionally, smaller samples may be analyzed making the technique applicable to more cases.

This study focuses only on standard residential window and tempered glass, indistinguishable by refractive index measurements, provided by the Illinois State Police Forensic Sciences Command. After the elemental fingerprints (i.e., mass spectra) and concentrations were acquired for the provided samples, the criteria for comparison and differentiation were determined. The primary approaches evaluated for classification/differentiation were: the presence or absence of elements; comparison of the abundance of selected elements; comparison of relative abundance of elements for specific association patterns; and multivariate analysis of the complete mass spectrum.

The multivariate analysis technique used, was Principal Components Analysis (PCA), which is an analysis tool for data compression and information extraction. PCA provides rapid analysis of samples without time-consuming pair-wise comparison of calibrated analyses. In general, PCA reduces a set of data into its most common variables or factors and expresses these variables as eigenvalues or scores that describe the major trends and variations in the data set. The scores can then be graphically used for discrimination of glass samples, since they provide an accurate description of the entire data set.

Glass Analysis, LA-ICP-MS, Chemometrics

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