A111 Forensic Glass Discrimination and Classification With Infrared Microprobe Analysis

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After attending this presentation, attendees will gain a better understanding of how infrared microprobe analysis can be applied to the forensic analysis of glass.

This presentation will impact the forensic science community by showing how infrared microspectroscopy can be used to aid in the discrimination and classification of glass evidence.

Glass is a ubiquitous material, and as a result, it is commonly recovered as transfer evidence when glass objects are broken during the commission of a crime. Vehicle windows, architectural windows, containers, headlamps, light bulbs, and mirror glasses are some of the major sources of this evidence at a number of crime scenes, including, but not limited to, car accidents, robberies, vandalism, bombings, and homicides. Broken glass is readily transferred to the breaker and to any individual or object in the vicinity of the breaking event; thus it has the ability to associate a suspect with a crime scene location or item and, in some cases, the time of occurrence. The significance of glass evidence is enhanced when the fragments are determined to be indistinguishable in all measured properties from the broken glass object. Conversely, if the recovered fragments differ in their measured properties from the broken glass object, then that glass object can be eliminated as a possible source of the glass from the suspect. The analysis of the molecular structure of glass is a novel forensic method that provides knowledge about glass chemistry that is not currently employed by forensic scientists as well as improves the discriminatory power within this class of transfer evidence.

Infrared (IR) spectra contain extensive information about the molecular structure of the complex silicates in commercial glasses. This research is based on measuring the Attenuated Total Reflection (ATR) mid-IR spectra of soda-lime silicate glasses to detect variations of the molecular structure to assist in the comparison of glass evidence.

The use of ATR mid-IR spectra for the discrimination and classification of glasses was investigated. Discrimination error rates of approximately 5% and classification by end-product (window or container) error rates of less than 2% were achieved with multivariate statistical methods, specifically Principal Component Analysis-Canonical Variate Analysis (PCA-CVA) and Partial Least Squares Discriminant Analysis (PLS-DA).

The mid-IR microprobe analysis of glass requires only minimal additional sample preparation to that which is already done for Refractive Index (RI) analysis and uses IR investigated samples that are the same size and smaller than the ablated hole made in Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS). Thus, mid-IR microprobe analysis can be used to provide additional discrimination for glass samples that are indistinguishable by RI and too small for elemental analysis. In addition, most forensic laboratories have IR spectrometers and/or microprobes which are used in the analysis of a plethora of evidence types including, but not limited to, paint, fibers, plastics, adhesives, and illicit drugs. Thus, this technique would not necessarily require a crime laboratory to purchase new instrumentation or require extensive training for trace evidence examiners. As a result, the use of ATR mid-IR microspectroscopy for forensic glass comparisons and analysis could potentially be implemented by forensic laboratories immediately and with minimal expense. ATR mid-IR spectral analysis provides information about the molecular structure of soda-lime silicate glass to support other traditional analysis and strengthen the association of this evidence.

Glass, IR Spectroscopy, Chemometrics