



### B8 Comparison of Femtosecond (fs) vs. Nanosecond (ns) Laser Ablation Sampling Coupled to ICP-MS for the Analysis of Glass and Other Matrices of Interest to Forensic Scientists

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After attending this presentation, attendees will be able to understand the role of laser ablation ICP-MS and its impact on forensic elemental analyses.

This presentation will impact the forensic community and/or humanity by observing how laser ablation ICP-MS is great complimentary elemental technique to aid in solving trace evidence related crimes.

This presentation will investigate the utility of femtosecond laser sampling prior to ICP-MS for the elemental analysis of glass and other matrices.

Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) has become an important tool for the elemental characterization and sourcing of samples of various matrices, including those of forensic interest. Due to its direct sampling capabilities, LA-ICP-MS offers many advantages over traditional dissolution methodologies. Such advantages include less sample consumption (nanograms compared to micrograms for dissolution techniques), the elimination of time-consuming and often dangerous sample preparation steps, an elimination of the contamination issues associated with digestion methods, and a reduction in spectral interferences. The major disadvantages of LA-ICP-MS include the requirement of matrix matched standards necessary for quantification, and the potential for elemental fractionation.

Many research groups have focused on the fundamentals of laser ablation in order to maximize both accuracy and precision; laser properties (i.e., laser-to-sample interaction), as well as sample transport from the laser ablation chamber to the ICP, remain important factors in minimizing fractionation. Therefore, when utilizing LA-ICP-MS, method optimization is crucial. Extensive research has well established that LA-ICP-MS is an excellent complementary technique to refractive index measures and fracture matching in association with forensic glass examination.<sup>1</sup> Glass examination continues to be an important tool in the investigation of many crimes of interest to the forensic community, including hit-and-run accidents, burglaries, and homicides.

The research presented compares the use of two different LA-ICP-MS systems, one in which a femtosecond (fs) laser is used and another that utilizes a nanosecond (ns) laser source for the analysis of glass. Previous research suggests that for nanosecond laser ablation, the ablation rate (the mass ablated per laser pulse) and fractionation is directly related to the sample matrix; thus, use of matrix matched standards is necessary for quantification.<sup>2,3</sup> Femtosecond laser ablation, due to its shorter pulse duration, greatly reduces thermal damage to the sample. As a result, there is a significant reduction in sample melting, which is believed to be the cause of the nonstoichiometric ablation (fractionation) associated with using nanosecond laser sources.<sup>2,3</sup> While there are matrix matched standards available for glass; this is not the case for most matrices of interest to forensic scientists.

The overall question is whether or not femtosecond laser ablation can significantly improve accuracy, precision, and discrimination power and, moreover, whether a femtosecond laser ablation system can be used for the analysis of samples *without* the need for matrix matched standards. Several parameters are considered in an attempt to answer the question. Both fs and ns sampling will be used in the analyses of certified glass standards as a means to assess accuracy, precision, and limits of detection for the analysis of these standards. A second study will determine the discrimination power (via pairwise comparison analysis) associated to each of the two laser ablation systems wherein 37 previously analyzed casework glass samples from windshields and architectural glass will be analyzed. A second discrimination study presents the results of the analysis of a set consisting of 41 vehicle windows collected between 1995 and 2005. Furthermore, the natural homogeneity/heterogeneity within a single pane of glass, namely a single windshield and a single pane of architectural glass will be presented. Finally, the use of a fs laser system without an internal standard in glass is evaluated, as this approach would increase the application of LA-ICP-MS to other matrices of interest to forensic scientists.

#### References:

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- <sup>3</sup> Russo RE, Mao X, Liu H, Gonzalez J, Mao SS (2002) *Talanta* 57: 425-451
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ICP-MS, Laser Ablation, Glass