B173 Elemental Analysis of Glass by LA-ICP-MS, a Comparison of Various Laser Methods to Optimize Sensitivity, Precision and Accuracy

Benjamin E. Naes, BS, Florida International University, Department of Chemistry and Biochemistry, 11200 SW 8th Street, Miami, FL 33199; Jhanis J. Gonzalez, PhD, and Richard E. Russo, PhD, Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720; Tatiana Trejos, MS, and José R. Almirall, PhD, Florida International University, Department of Chemistry and Biochemistry, 11200 SW 8th Street, Miami, FL 33199*

After attending this presentation, attendees will learn how to charac- terize glass, collected at crime scenes, using laser ablation inductively coupled plasma mass spectrometry, ultimately for discrimination purposes and learn the fundamentals of laser ablation ICP-MS and why it is an emerging technique for elemental analysis of forensic materials.

This presentation will impact the forensic community and/or humanity by illustrating the utility of laser ablation inductively coupled mass spectrometry as an excellent method for characterizing glass frag- ments, collected at given crime scenes, and then using this characterization to match the fragment(s) back to the source. The net result of such deter- mination and discrimination measures is to assist with linking a person or object to a crime scene or crime scenes.

Bombings, drive-by shootings, burglaries, assaults, and automobile hit and runs are just a few of the cases in which glass fragments, collected at a crime scene and/or transferred to a suspect or a secondary crime scene, can become a key factor in solving crimes[1]. Glass examiners often employ tra- ditional techniques, such as fracture matching, as well as various optical and physical associations, such as color, thickness, and refractive index (RI) determination; oftentimes, these techniques do indeed provide effi- cient means to associate a person or object to a particular crime scene[1]. Nevertheless, characterizing glass fragments solely on the physical and optical properties does not provide as good discrimination as does the com- parison of trace elemental profiles. Previous researchers, have discovered that the trace elemental analysis of glass fragments can compliment tradi- tional comparison techniques providing for additional discrimination between glass samples originating from different sources. Techniques including x-ray fluorescence, neutron activation, scanning electron microscopy, and atomic absorption have all been utilized for elemental glass profiling; however, inductively coupled plasma mass spectrometry (ICP-MS) has emerged as the method of choice for trace elemental profile determinations[1]. In comparison to other elemental analysis methods, ICP- MS offers many advantages, including enhanced sensitivity, multi-element determinations, and high sample throughput[1]. Moreover, research has demonstrated that both dissolution (acid digestion) and laser ablation sam- pling methods offer competitive means en route to accurate and precise analytical results for the analysis of glass. Nevertheless, it has been shown that laser ablation offers many distinct advantages to its dissolution counterpart, including an elimination of health-related issues (use of concentrated acids is not required), also, laser ablation has much smaller sample-size requirements (~ picograms versus ~ milligrams for dissolution techniques), and, most importantly, no sample preparation is necessary for laser ablation because of its direct sampling approach (thereby equating to faster analyses)[2].

This research will focus on laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), with emphasis on the comparison of two types of laser sampling devices, a femtosecond (fs) laser system and a nanosecond (ns) laser system, and its application to the analysis of glass. As compared to nanosecond laser ablation, femtosecond ablation is advanta- geous for such laser systems ablate smaller aerosol particle sizes, laser- plasma interactions are greatly reduced, less plasma shielding occurs, and minimal sample lattice heating results; to add to that, femtosecond laser ablation is essentially non-thermal, which equates to the possible elimination of matrix dependence and fractionation[2,3]. Along with the analysis of NIST certified glass standards, twenty-one different glass samples originating from vehicle windows were analyzed by LA-ICP-MS, using both nanosecond and femtosecond lasers, as well as the utilization of different types of inductively coupled plasma mass spectrometers, a quadrupole instrument and a magnetic sector instrument. Characterization of these glass samples using laser induced breakdown spectroscopy (LIBS) has been performed by this laboratory; therefore, comparisons between LIBS data obtained and the LA data obtained in the given experiments will be discussed, as well as general background information related to this technique.

In addition, a secondary laser ablation analytical approach will be presented; secondary, in the sense of collecting an ablated mass onto a sub- strate followed by the ablation of the substrate (containing the ablated mass). The theory behind this technique involves the rationale of pre-con- centrating the material of interest, in this case, glass, onto the substrate, and then increasing the laser spot size for the secondary ablation, which will ultimately increase the number of particles entering the ICP-MS over the same time, and, thus, an increase in sensitivity can be obtained. It is important to point out that for trace elemental determinations, sensitivity is crucial; therefore, in summation, the research presented in this paper will focus on the different ways to optimize such sensitivity with respect to forensic glass examination while retaining the precision and accuracy already achieved and previously reported.

References:

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 ** Presenting Author*

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 ** Presenting Author*