B61 An Analysis of Standard Glass Reference Materials Via Advanced Chemical Techniques for Forensic Applications

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After attending this presentation, attendees will understand how various techniques, including Glass Refractive Index Measurement (GRIM), Neutron Activation Analysis (NAA), Time-Of-Flight/Secondary Ionization Mass Spectrometry (TOF/SIMS), and Laser Ablation-Inductively Coupled Plasma/Mass Spectrometry (LA-ICP/MS) have been used to characterize several internationally available glass reference materials. The goal of this research was to measure elemental concentrations and stable isotope ratios in several glass reference materials, some of which have not been previously characterized, and thus enhance their value as reference materials.

This presentation will impact the forensic science community by illustrating that the main research outcomes presented in this study are stable isotope ratios and trace element concentrations in a range of soda lime and borosilicate glass reference materials. These values can be used for matrix-matched calibration of instruments used for the elemental analysis of glass, and thus have impact in regard to improving the quality of trace evidence examination. Furthermore, this presentation describes the scope and limitation of TOF/SIMS for the semi-quantitative analysis of trace elements in glass for forensic purposes.

All the reference materials (soda-lime glasses National Institute of Standards and Technology (NIST) 612, Float Glass Standards (FGS) 1, FGS 2, and borosilicate glasses NCS DC61104 and NIST 93a) were analyzed to determine if they had refractive indices relevant to forensic casework. This was accomplished via the oil-immersion temperature variation method using a Foster + Freeman GRIM® 3 instrument.

The soda lime glass reference materials were quantitatively analyzed by NAA at the Australian Open Pool Australian Light water (OPAL) nuclear reactor. Compositional data were generated by NAA for more than 20 elements in FGS1 and FGS2, including at least nine that were not measured in the previous research by Latkoczy et al., or the American Society for Testing and Materials (ASTM) inter-laboratory study.[1,2] NAA analysis of NIST 612 gave concentrations for 29 elements, including 10 for which no data are given on the certificate of analysis, and these values agree with the average values from other literature sources.[3,4] Trace element concentrations were also measured using LA-ICP/MS and semi-quantitatively determined using TOF/SIMS. The precision of the measurements using each of the techniques was used to determine the relative suitability for each technique for forensic microanalysis of glass.

The borosilicate glass reference materials NCS DC61104 and NIST 93a were analyzed using multi-collector ICP/MS to measure boron and lithium concentrations and stable isotope ratios and TOF/SIMS was used for the semi-quantitative analysis of trace element concentrations. Currently, these standards only have published concentration values for major elements and not for trace element analysis or any isotopic ratios.[5,6] Sensitive High-Resolution Ion Microprobe (SHRIMP) is a multi-collector mass spectrometric technique that can be used for the direct analysis of very small particles with high mass and spatial resolution. This technique was used to conduct replicate measurements of boron and lithium isotope ratios of several chips taken from different regions of the glass standards to check for compositional homogeneity. NAA and LA-ICP/MS analyses of these materials were not possible due to the high boron content of the samples.

The main research outcomes given in this presentation are stable isotope ratios and trace element concentrations in a range of soda lime and borosilicate glass reference materials. These values can be used for matrix-matched calibration of instruments used for the elemental analysis of glass, and thus have impact in regard to improving the quality of trace evidence examination. Furthermore, this presentation describes the scope and limitation of TOF/SIMS for the semi-quantitative analysis of trace elements in glass for forensic purposes.

Reference(s):

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Glass Reference Materials, Micro-Chemical Analysis, Neutron Activation Analysis

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