B110 Development of an Ion Beam Analysis Method for Forensic Analysis of Glass

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The goal of this presentation is to provide an introduction to ion beam analysis techniques for use in forensic analysis and discrimination between glass samples.

This presentation will impact the forensic community by indicating that there may be a role for ion beam analysis techniques in discriminating between glass samples. Ion beam analysis techniques are applicable to a range questions involving the forensic analysis of trace evidence.

The goal of this project was to develop a relatively rapid and non- destructive method for the comparison of glass samples for forensic study. While several other instrumental techniques exist that use variations in trace element signatures to discriminate among samples from different sources, ion beam analysis might be able to provide a cost-effective solution with higher sensitivity that X-ray fluorescence, and less sample preparation and alteration than laser-ablation mass spectrometry. Ion beam analysis encompasses a suite of experimental techniques that are available with a charged particle accelerator, which for this analysis included simultaneous measurement of Particle-Induced X-ray Emission (PIXE) and Rutherford BackScattering (RBS).

With recent advances in low-energy accelerator technology, stable relatively high-flux beams of accelerated protons and alpha particles become available for rapid ion beam analysis of samples that can withstand high vacuum. The Hope College Ion Beam Analysis Laboratory has a 1.7 MV tandem pelletron accelerator which was used to accelerate protons to energies of 3.4 MeV. This beam of accelerated protons was used to irradiate sample glass fragments mounted in a target vessel with only minor sample preparation. X-rays that result from the inner shell vacancies induced by the ion bombardment are used to identify and quantify the target atoms for all trace elements heavier than silicon. Elastically scattered protons are also detected at back angles and can be used to identify majority constituents and to normalize the incident beam intensity from run to run.

The PIXE data are recorded for multiple runs per sample and analyzed by a commercial x-ray peak-fitting program: GUPIXWin. The results, typically recorded in part-per-million concentrations of nine elements heavier than potassium, are normalized by the RBS measurements of beam intensity and are entered into a spreadsheet for subsequent statistical analysis. A protocol was developed to compare unknown glass specimens to a reference glass specimen using a z-score analysis of absolute concentration of each element, as well as elemental ratios and normalized concentrations of each element. If any sample obtained a z-score>3 for all three comparisons it was determined to originate from a different source glass material. The second step of the analysis protocol involved further ion beam analysis on a reduced number of samples that passed the first comparison test. Replicate runs on each target of interest were then discriminated using a t-test to select samples from different sources.

This presentation will provide an introduction to the ion beam analysis techniques developed specifically to optimize this non- destructive testing of glass fragments for forensic identification and sourcing. The results of a double-blind test on 17 glass samples will be presented as well as a summary of potential applications of this technique for forensic analysis. Such examples will include the possible control of surface effects by target orientation and the sample preparation technique we have developed, which might allow this analysis to be extended to very small glass samples using our proton microprobe option for ion beam analysis.

Ion Beam Analysis, PIXE, Glass

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