B163 Elemental Analysis by LA-ICP-MS at the Netherlands Forensic Institute

Shirly Montero, PhD, Maarten Hordijk, Ir, Wim Wiarda, Ing, Peter de Joode, Ing, and Gerard J.Q. van der Peijl, PhD, Netherlands Forensic Institute, PO Box 3110, Rijswijk, ZH 2280 GC, Netherlands*

After attending this presentation, attendees will understand the discrimination potential of LA-ICP-MS for the elemental analysis of different types of materials of forensic interest.

This presentation will encourage the adoption of methods with the high discrimination potential for forensic applications rendered by the (LA-)ICPMS technique. This presentation focusses on a few of these applications.

The value of trace evidence has been established for some time through numerous studies and publications. Recovered samples associated with a suspect and samples associated with a known source sometimes may be compared to each other based on the optical and other physical properties as well as the chemical composition of such samples. Moreover, such comparisons have been shown to be useful as a source of investigative information, not only for the associative purpose mentioned above such as relating a suspect to a crime scene but also for reconstruction of events. The significance of the results of these comparisons can only be estimated by the analysis of the information obtained from appropriate databases. The choice of methods to characterize and compare trace evidence depends on, among other factors, the size of such evidence. It is known, for example, when a piece of a material is broken, the fracture surface will often have unique topological features. When the surface is large enough, the features produced by the fracture may be so abundant as to permit a distinctive association between two sections, like in two pieces of a jigsaw puzzle. This physical matching is the most definitive way of relating samples that were once a single piece. However, when the physical matching is not possible other properties can be measured.

The decrease in the variation of physical properties in evidence of the same kind, i.e. by increased quality control by manufacturers, limits the discrimination potential of the methods used to measure such properties. The use and value of elemental analysis for characterization of materials of forensic interest becomes important in such cases. Furthermore, when the dimensions of a sample are small, very sensitive methods are needed in order to measure reliably the elemental composition, in particular at trace levels. The last few years, efforts have been made by different research laboratories to develop and validate analytical methods with better sensitivity, precision and reproducibility.

Various instrumentation available in forensic laboratories has been used for the elemental analysis of evidence samples (e.g., glass, paints, fibers), among them SEM-EDS, XRF, ICP-AES, ICP-MS and more recently LA-ICP-MS. This last technique combines the sensitivity and precision of ICP-MS with the advantages of laser ablation sampling. With the use of LA-ICP-MS there is no need for laborious and lengthy digestion procedures with dangerous chemicals. In addition, the common analytical interferences that are increased by the presence of solvents are minimised using laser sampling, improving the detection limits of some potentially discriminating elements. The amount of material ablated for the complete analysis is very small (~fg), allowing the analysis (including replicates) of very small samples. The destruction is minimal with craters in the order of 10^{-8} m^2, in contrast to the solution approach where the whole sample to be analysed is irreversibly digested.

For this study, analytical methods for the elemental analysis by LA- ICP-MS of materials of forensic were optimised and validated in our laboratory at the Netherlands Forensic Institute. The system used is an ICPMS (Perkin Elmer ELAN6100 DRC) in combination with a 3 mJ213 nm-laser ablation system (New Wave UP-213). The standard reference materials (SRMs) NIST 612, 1830 and 1831 were used for the development and validation of a quantitative method for glass analysis. The SRM NIST 612 is a synthetic glass of well-characterised trace elemental composition. This SRM was used to select an appropriate elemental menu based on reproducibility and accuracy. The other two SRMs are not certified for all trace elements but they were used for the optimization of the method for analysis of float glass (similar matrix) as well as controls to monitor the stability and performance of the instrument during the analysis. This method was then used to analyse ~200 float glass samples collected by the police from different locations within the Netherlands where a burglary had taken place. Although these samples were not submitted as evidence they are considered representative of possible casework samples. In addition, the refractive index of all the samples was measured using a GRIM II. Less sensitive semi-quantitative elemental composition measurements were performed using XRF. All samples were inter-compared using elemental compositions and refractive index values. These comparisons were performed using the SPSS statistical software package and were used to evaluate the discriminating value of each element measured with the two methods in addition to that for the refractive index. Both the methods and the results of the comparisons of the samples will be discussed in this presentation. In addition, the development and validation of semi quantitative methods for the analysis of other materials of forensic interest such as automotive paints, inkjet inks and amphetamines will also be addressed.

LA-ICP-MS, Elemental Analysis, Trace

 ** Presenting Author*