B102 Comparison of the Elemental Profiling Techniques of Laser Ablation-Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) and Laser Induced Breakdown Spectroscopy (LIBS) for Forensic Automotive Paint Samples

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The goal of this presentation is to present to the forensic community elemental profiling data from the analysis of forensic automotive paint samples.

Automotive paints are frequently encountered forms of trace physical evidence in forensic science laboratories and represent a portion of the elemental analysis study of trace evidence underway in the Florida International University laboratory. The laser techniques of Laser Ablation-Inductively Coupled Plasma Mass Spectrometry (LAICPMS) and Laser Induced Breakdown Spectroscopy (LIBS) have been developed to better characterize these samples for forensic purposes.

LA-ICP-MS has been used on forensic samples such as glass, plastic automobile lenses, pen inks, and tapes. This study has extended its potential uses to automotive paints. The advantages of this technique over existing techniques include minimal sample preparation and minimal destructiveness, the ability to examine all paint layers simultaneously, and its improved sensitivity and limits of detection over Scanning Electron Microscopy –X-Ray analysis, the current elemental analysis technique of paints in forensic laboratories.

The ICP-MS system used for this work was an Agilent (HP) 4500 Plus Shield Torch System (Agilent, Palo Alto, CA, USA) equipped with a LSX-200 Plus laser ablation system (CETAC Technologies, Omaha, NE, USA). Additionally, an LSX-500 Plus laser ablation system was used and the results from this laser are compared to the LSX-200 Plus results. The comparison between the energy density differences (nominal 5 mJ output for the LSX-200 and 9mJ for the LSX-500) and the effect of the energy differences on the elemental analysis results are also presented.

Since its initial use in 1962, LIBS has become a well-known atomic emission technique that allows for rapid elemental analysis. A laser pulse is focused on a sample surface and excites a sample's atoms, light is emitted, and the emission is detected and analyzed spectroscopically. The emission spectrum is then used to determine the elemental components of the sample. LIBS has previously been used in the identification of pigments in works of art and for determination of lead in house paints. Due to the nature of artwork and forensic samples, it is desirable for a potential technique to be non-destructive or nearly non-destructive, and the LIBS technique meets this criterion. In addition to speed and versatility, other advantages of LIBS are minimal sample preparation, affordability in comparison to LA-ICP-MS and the potential for portability. In this way, LIBS could be used for on-site analysis to potentially reduce operator and instrument time in the laboratory and allow for faster results.

For the LIBS analysis, the laser systems mentioned previously are used in conjunction with the CETAC Endpoint 2000 Spectrometer (300 nm range, 0.5 nm resolution).

A sample set of casework-like automotive paint samples is analyzed by the LA-ICP-MS and LIBS techniques. The optimal laser parameters such as ablation method, spot size, laser power, and frequency of the laser pulse are discussed. Homogeneity studies have been conducted with the developed method. Due to a lack of matrixmatched standards, no true quantification can be calculated for most elements of interest, but quantification results and detection limits for the measurement of lead (Pb) are reported based on NIST (National Institute of Standards and Technology) Standard Reference Materials 2570-2575 (lead paint films) manufactured for portable XRF analyzers. Additionally, the elemental profiles of some real automotive paint samples and an evaluation of the utility of these techniques to discriminate between different paint samples are presented. LA-ICP-MS and LIBS both show great promise for the detection and analysis of trace and minor metals in forensic automotive paint samples.

Automotive Paint, LA-ICP-MS, LIB

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