Direct Elemental Analyses of Ink on Paper by Laser Ablation ICP-MS

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The CETAC LSX-500 Laser Ablation System is suitable for trace element microanalysis of virtually any solid sample. Here we describe the use of the LSX-500 for elemental analysis of inks on paper.

Introduction

Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) has already successfully been applied to applications in geology, forensics, ceramics, metals, glasses and a wide variety of environmental and industrial materials (1). For forensic analyses, materials research and quality control, the analysis of ink applied to paper or other substrates is necessary. For analyses of inks from an inkjet printer or toner from a laser printer, the extraction of ink from the paper may be difficult or impossible. The ability of the CETAC LSX-500 to ablate thin layers and deliver sufficient material to the ICP or ICP-MS is required for such analyses. The LA system must be able to deliver flexible ablation patterns, possess high resolution imaging for locating the sampling area and be adaptable to a variety of sampling cells to accommodate various size samples.

Experimental Conditions

The CETAC LSX-500 is a high power 266 nm LA system that has improved performance over traditional 266 nm LA systems. For ink analyses, ink jet ink from several manufacturers were obtained on 25% cotton bond paper. Laser printer toner, offset printing ink and ink on plastics were also obtained for analysis. Forty elements were analyzed simultaneously by the ICP-MS, using a large beam size (500µm) and a fast scanning speed to raster the beam in a shallow track.

Results

The trace element differences between ink manufacturers, between colors and between toners were easily resolved by the LSX-500 with ICP-MS. It is possible to show the start of ablation in paper, the time of initial ablation in the ink and the duration of the ink signal (Figure 1). The average signal intensities for selected elements of black inkjet ink are shown in Figure 2. For many elements and elemental ratios, clear differences between ink jet inks are resolved by LA-ICP-MS. For laser printer toner and other inks similar differences have been seen.

Using the built in graphics capabilities and superior on-screen imaging of the LSX-500, the time resolved data from the ICP-MS can be placed directly on the image of the ablated line. The flexible sample cell assembly of the LSX-500 allows a variety of standard and custom cells to be easily mounted for handling a variety of different sized documents.

Conclusions

The LSX-500 is a powerful tool for the analysis of ink on paper. The results provided here are sufficient to identify the elemental composition of each ink color, discriminate between different ink manufacturers. The CETAC LSX-500 is a useful tool for this and similar applications in forensic labs, industrial research and manufacturing labs. The LSX-500 is also a versatile tool for any lab that is interested in elemental sampling of solids without difficult sample preparation.

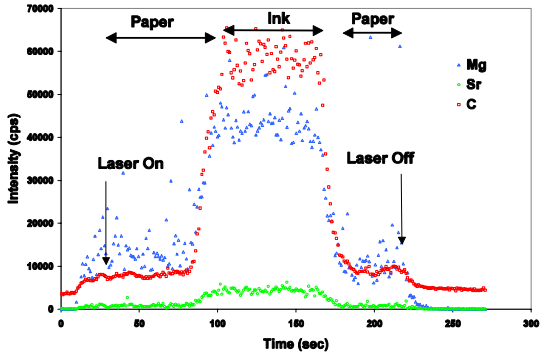

Figure 1: Time resolved ICP-MS spectra for analysis of ink on paper. The change in chemistry marks the intersection of the laser with the ink

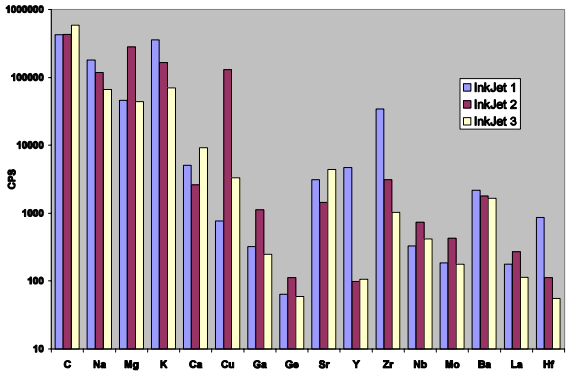

Figure 2: A plot of average ICP-MS signal for black inkjet ink from three manufacturers. Note the strong differences in elemental composition among the inks.

References

(1) Günther, D., Jackson, S.E., and Longerich, H.P. Spectrochim. Acta Part B, Review, 54, 381-409 (1999)