J14 Applications of Novel Methods of Elemental Analysis to the Field of Document Examination

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This presentation will provide the forensic document community with knowledge of recent developments in analytical instrumentation for the determination of elemental concentrations in solid materials, which have resulted in improved capabilities for nondestructive or minimally destructive examination of documents. These techniques could prove useful in the forensic analysis of inks and obliterated writings.

Several recent developments in the design of analytical instrumen- tation for the determination of elemental concentrations in solid materials have resulted in improved capabilities for nondestructive or minimally destructive examination of documents. Attendees of this presentation will learn about the results of studies applying two techniques, micro-x-ray flu- orescence (μXRF) and laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS), to several problems of interest to document examiners.

LA-ICP-MS is an analytical technique in which a laser is used to ablate a solid material into a fine particulate mist that is swept into argon induc- tively coupled plasma for atomization and ionization, and finally, a mass spectrometer for quantitation of the isotopic ions produced. This technique is minimally destructive, in that an ablation area between 50 and 300 μm in diameter is typically removed from the sample surface. By appropriate selection of laser power and wavelength, a microscopic portion of an ink layer may be removed from a document without visible destruction of the underlying paper. Such a small sample is adequate for semi quantitative determination of the concentrations of several elements with only minimal destruction of to the document (not visible to the casual observer). In a study using a collection of BIC® ball point pens containing black ink, most of the pens could be distinguished from each other by analysis of ink strokes directly on paper. Variations in elemental response over the course of writing with ink throughout a pen reservoir and corrections for elements present in the paper will be discussed. Variations in the elemental composition of the ink reservoir of a pen and the paper chemistry will be discussed.

XRF methods have long been used for characterization of documents, primarily because they can provide useful elemental information in a non- destructive manner. The development of instruments that utilize a capillary for transmission of the x-rays from the x-ray tube to the sample surface has provided new opportunities for use in document examination. By irradi- ating a small area on the surface of a sample that is mounted on a motorized stage, mapping of the elemental distributions over a two-dimensional area is possible. This technique has been previously been utilized in the char- acterization of inks and papers of documents of historical interest. This pre- sentation, will discuss the utilization of μXRF for the visualization of oblit- erated writing. An ink utilized used to obliterate writing made by a dif- ferent ink or other medium will often contain differences in its x-ray fluorescence spectrum from that of the underlying writing. By scanning the document with an x-ray beam in a grid pattern, the differences in x-ray intensities from the two writing media layers have been utilized used to form a digital image of the underlying obliterated writing by measurement of the x-rays escaping through the obliterating layer. Because these images are based on minor elemental compositions, they may be formed for ink combinations that cannot be visualized using molecular spectroscopy, visual spectral comparison measurements, or hyperspectral imaging. The combination of methods provides the document examiner with an arsenal of complimentary techniques for visualization of obliterated writing.

Trace Evidence, Ink Analysis, Obliterated Writing

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