



Questioned Documents Section - 2012

J14 An Elemental Approach to Forensic Document Examination

Fary L. Lee, MS, Foster & Freeman, USA Incorporated, Summit Forensic Document Laboratory, PO Box 207, Eden, UT 84310; and David Tobin, Owen Lang, MFS, and Michael Zontini, BA, Foster & Freeman, USA Incorporated, 46030 Manekin Plaza, Sterling, VA 20166*

After attending this presentation, attendees will learn about the use of the Elemental Composition Comparator (ECCO) that may be applied to forensic document examination. Introduced is the theory and application of the ECCO that employs Laser Induced Breakdown Spectroscopy (LIBS) for the elemental examination of paper, banknotes, inks, metallic foils, and coins. The results of this research will be presented.

This presentation will impact the forensic science community by enhancing the understanding of the discriminating power of this methodology, as it relates to the examination of questioned documents.

The substitution of a page within a multiple page document such as a will or contract, counterfeiting of paper banknotes and coins, and associating ransom or extortion notes, have all been the focus of forensic document examination. The comparison of the elemental composition of questioned documents, determined by LIBS, can further assist the forensic document examiner in the examination of questioned documents. LIBS, also known as Laser Induced Plasma Spectroscopy (LIPS) is basically an emission spectroscopy technique where atoms and ions are primarily formed in their excited states as a result of interaction between a tightly focused laser beam and the material sample that can be used to quickly determine the elemental composition profiles of a gas, liquid, and solid samples with minimal sample preparation. This technique is based on the analysis of spectra emitted by atomic species and the excitation of those elements by creating a plasma using a low energy laser source. This technique is based on Atomic Emission Spectroscopy (AES) which can be used to determine the elemental composition of a substance. Described simply, AES is achieved by measuring the light emitted from an electronically excited atom as it drops from a high energy state to a lower energy state. LIBS has evolved quickly over the past twenty years and is experiencing exponential growth in interest and finds today a growing number of applications. The advantages of LIBS are that the technique is relatively non-destructive, requires very little sample preparation, and the spectra can be obtained instantaneously. The disadvantages of LIBS are that the limit of detection is presently only 4-10 parts per million (ppm) and the percent composition of trace elements cannot be determined to the level of accuracy required for forensic analysis. However, LIBS can be used as a quick test when specific elements can be used to identify a sample.

ECCO uses this analytical technique called LIBS. LIBS, as previously stated is an atomic emission technique that determines which elements are present in the target sample. This means that the record of a spectrum is based on the breakdown of a sample that was created by a laser. This will then allow a comparison of the elemental composition of sample materials based on the spectra that they give. ECCO uses a high power pulsed infra-red laser that is focused onto a sample raising the temperature by up to 15,000°C which produces a micro-plasma of the sample. The micro-plasma contains excited atoms and ions of the elements within the sample. The plasma then emits ultra-violet and visible colored light, which is collected by the spectrometer. The peaks seen on the spectra are called atomic emission lines. Each element has its own signature or pattern of atomic emission lines of both wavelength and intensity. Therefore, it is possible for elements to be identified from the peaks that are present. The atomic spectrum of the constituent elements of the target sample provides a material “fingerprint”.

ECCO using LIBS offers significant advantages in speed, sensitivity and cost effectiveness over other processes such as x-ray fluorescence, scanning electron microscope, and mass spectroscopy. Examinations conducted with the ECCO are not only fast and simple to perform, but require minimal sample preparation, gives an immediate spectra of the elements down to low parts per million, and the examination process is only minimally destructive. This presentation will show the varied applications of ECCO in the elemental analysis of questioned documents such as security paper, office paper, envelopes, differentiating between genuine and counterfeit banknotes and coins, pencil leads and toners.

Elemental Composition Comparator, Laser Induced Breakdown Spectroscopy, Forensic Document Examination