Elemental Analysis by Agilent ICP-MS - A Powerful Tool for Investigations in Forensic Science

Forensic scientists use accurate measurements of elements in crime scene evidence to characterize and identify materials. This "element fingerprint" relies on a precise and accurate means of measuring multiple elements in different types of samples. For some elements, non-natural isotope abundances similarly "fingerprint" materials, allowing scientists to correlate seemingly disparate samples. These measurements are useful both in the analysis of scene of crime debris and also in cases of industrial forensic analysis, such as proof of origin, failure analysis and inclusion identification.

Element profiling has relied on the use of older traditional techniques such as Graphite Furnace Atomic Absorption Spectroscopy (GFAAS) or Neutron Activation Analysis (NAA). Both techniques have individual merits, however measurements are time consuming and cost per analysis is relatively high. ICP-MS offers forensic scientists a rapid and sensitive means of measuring many elements in a single analysis. As a mass spectrometric technique, ICP-MS also provides users with isotopic information, an extra degree of freedom when characterizing evidence.

The Agilent 7500 Series ICP-MS is particularly suited to forensic applications. The robust sample introduction system is built around an industry standard, crystal controlled 27.12MHz RF generator. This provides users with total flexibility; and a wide range of optional sample introduction accessories are available, further extending the capabilities of the instrument.

Analysis of Gunshot Residues (GSR)

When a person fires a handgun, traces of the explosive material in the ordnance are deposited on their hands. Analysis of this residual material can yield characteristic distributions of certain elements linking the user of the weapon to a given occurrence or crime scene.

Sample collection is a simple matter of swabbing a suspect's hands with clean cotton-buds; sample preparation involves soaking the swabs in 10% nitric acid. Full details of the method are summarized in Agilent Application Note pub number 5988-0532EN.

Table 1 summarises the analysis of four samples taken from a person who had fired a handgun. Swab samples were taken from the palm and back of both hands, 40 minutes after the weapon was discharged. Note that the gun was fired double handed. The distribution of Sb, Ba and Pb show good agreement across the samples.

Sample	^{121}Sb (µg)	^{138}Ba (µg)	^{208}Pb (µg)
Left Palm	1.26	4.09	5.33
Back of left hand	0.27	0.91	1.5
Right Palm	2.2	8.18	11.1
Back of right hand	0.12	0.4	0.91
Swab blank	0.007	<0.001	<0.001

Table 1 Analysis of gunshot residue (GSR) samples by Agilent ICP-MS

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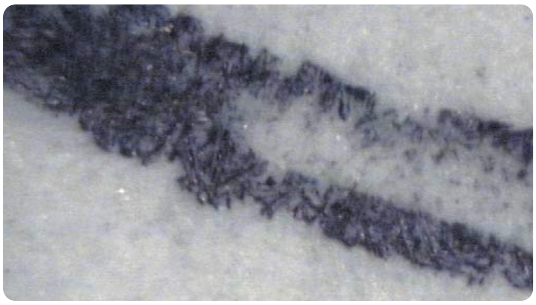

Figure 1 Magnified photograph of ballpoint pen ink sample after LA-ICP-MS sampling

Laser Ablation to Extend the Capabilities of ICP-MS

High power solid-state lasers can be used to volatilize solid samples for ICP-MS analysis. Laser Ablation ICP-MS (LA-ICP-MS) is used widely by scientists measuring trace components in samples that are difficult to digest, or where small fragments or inclusions must be analyzed.

The glass used in the headlights and windows of automobiles is often unique to a manufacturer, and the elemental profile can be used to identify the marque, brand or even year of manufacture of the vehicle. Trace element content offers far better discrimination than the traditional refractive index (RI) method. LA-ICP-MS provides a fast and simple means of characterizing glass fragments found on a suspect's clothing or at the location of an accident, without time-consuming sample preparation.

The technique can also be applied to other samples such as identifying inks on suspect documents or element profiles in fiber samples and other scene of crime debris. Figure 1 illustrates a sample of ballpoint pen ink after analysis using LA-ICP-MS. The ablated portion of the ink is clearly visible on the right side of the photograph.

Summary

As a powerful and precise means of analyzing a wide variety of sample types, the Agilent 7500 Series ICP-MS offers forensic scientists a perfect tool for investigation.

Key features of the 7500 Series that ensure robustness and reliability include:

- Peltier cooled spray chamber - reduces solvent vapor loading producing a more robust plasma
- High ion transmission at low sample uptake rates (50-400 uL/min), reduces plasma loading while maintaining high sensitivity
- High energy, solid state 27.12MHz plasma for optimum energy transfer and complete sample matrix dissociation
- A unique, fast detector that operates with a linear dynamic range of 9 orders of magnitude - necessary for fast transient signal analysis
- Unique servo motorized 3-axis torch positioning provides precise and reproducible optimization of the plasma sampling position, including the critical depth at which ions are sampled from the plasma.

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