A190 Forensic Discrimination of Copper Items Using Trace Element Concentrations

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After attending this presentation, attendees will understand the general principles of source discrimination, method development for determination of trace element concentrations using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), and the statistical comparison of trace element concentrations in copper from different sources for discrimination among and association between sources.

This presentation will impact the forensic science community by potentially providing a new means to associate crime scene and suspect-linked copper items based on their trace element concentration profiles.

Copper can be encountered in criminal cases such as theft (as raw material from mines and as wiring or piping from construction sites and homes) and bombings (wiring in explosive devices). At present, the only means of reliably associating copper items is on the basis of fabrication marks, which may not be possible in all cases depending on the copper item. The goal of this research is to assess the potential of using the trace element concentrations of a copper item from a crime scene to either associate or eliminate as a source a copper item associated with a suspect.

The conductivity of copper is dependent on its purity (i.e., concentration of trace element contaminants). Rapid techniques such as spark source optical emission spectroscopy and X-ray fluorescence spectroscopy are commonly used in production laboratories to determine trace element impurities in copper. However, quantitation limits for these techniques are close to or higher than the analyte concentrations in high purity copper. Due to the requirement of lower detection limits, an alternative method based on ICP-MS instrumentation was explored.

Concentrations of trace elements in copper were initially determined using solution ICP-MS in NIST standard reference materials for method validation. It was determined that a microwave digestion step after initial dissolution of the copper samples in concentrated nitric acid was required to achieve quantitative recovery of all analyte elements. The standard reference materials were also used to construct a matrix-matched calibration curve, which was compared with non-matrix-matched calibration. To increase the number of elements available for source discrimination, noncertified elements present in the standard reference materials were identified as present using solution and laser ablation ICP-MS, although the accuracy of the method for these elements cannot be confirmed. Relevant figures of merit determined include method detection limits based on 10 replicate blanks that were carried through the sample preparation process, matrix effects due to high concentrations of copper, method accuracy by comparison of measured and certified analyte element concentrations, and reproducibility of the sample preparation and measured concentrations.

To discriminate between copper items, the variation in trace element concentrations within a “source” (e.g., from different parts of the copper item and/or from the same production batch) must be small compared to the variability in trace element concentrations between production batches from the same manufacturer, items produced by different manufacturers, and geographic location of raw material mining. Samples were collected to represent copper from different geographic regions, refining operations, and production procedures used to produce specific types of copper items. Statistical techniques are used to identify elements that contribute significantly to the variation within and between samples, and to group samples based on their trace element concentration profiles. Statistical analysis of the trace element concentration profiles could potentially provide a link between the copper item recovered from the crime scene and an item associated with a suspect, or exclude a suspect from further investigation.

Source Discriminatio, Trace Elements, Copper

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