B47 Casework Investigations for Tapes, Polymers, Ink, and Paper Using IRMS and (LA-) ICPMS Studies

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After attending this presentation, attendees will appreciate the strong potential of Isotope Ratio Mass Spectrometry (IRMS) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-)ICPMS for a wide spectrum of forensic investigations.

This presentation will impact the forensic community and/or humanity by demonstrating new interesting forensic applications of the (LA-)ICPMS and IRMS elemental and isotopic techniques have been developed and are demonstrated to result in much more discriminating methods for forensic applications. The subject in the present presentation touches on a limited number of investigations but is very useful in demon- strating the relevance of these techniques. Results are presented for various casework investigations using the IRMS (Isotope Ratio Mass Spectrometry) and LA-ICPMS techniques that are still used infrequently for investigations within the forensic community.

Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-)ICPMS and Isotope Ratio Mass Spectrometry (IRMS) method devel- opment studies for various materials has been previously presented at the AAFS meeting. These techniques are use for a wide variety of forensic material casework investigations (various tape types, glass, XTC, paper, sawdust, ink, bullets, brass and other metals, rope materials, cables, poly- meric jerrycan remains in arson residues, human materials for tracing geo- graphic origin unidentified human victims). For forensic LA-ICPMS glass investigations a validated and accredited routine method has been developed (http://www.forensicinstitute.nl/documents/Glass_validation_ report.pdf). For a selected number of general casework investigations experiences are shared and general trends and aspects discussed.

The general trends and aspects of LA-ICPMS and IRMS casework investigations mostly center on material comparisons, *i.e.* does this piece of material as found at the crime scene and similar material as found with the suspect originate from one source? As one hypothesis the materials are therefore considered to originate from one source (*i.e.* roll of tape). Most of the investigated materials are industrially produced in production batches. As alternative hypotheses, researchers would typically consider that materials are from the same production batch or from another pro- duction batch but the same producer or from other random producers. Weighing of the evidence is based on scientific literature results and Netherlands Forensic Institute, part of Ministry of Justice (NFI) investiga- tions on limited numbers of samples to test literature information applica- bility for the Dutch situation. An interactive process is used in reporting. Mostly (fast, softer) forensic intelligence is generated for the police inves- tigation phase. For the court evidence phase in first instance the findings are reported as of that moment and mention possible follow-up studies. Dependent on the court response some aspects of the first investigation may be further substantiated in a follow-up study.

Brown packaging, gray or black duct and PVC tape types were inves- tigated in some fifteen casework investigations, mostly in relation to serious crimes. Tapes were always first investigated using classical tech- niques such as FT-IR and visual (microscopic) comparison. Mostly tapes were contaminated with dust and other debris. Sometimes tapes had been treated chemically to visualize fingerprints. Laser Ablation Quadrupole Inductively Coupled Plasma Mass Spectrometry (LA-Q-ICPMS) was used in all cases for both backing and adhesive layers. Often, results were cor- roborated using Laser Ablation High Resolution Inductively Coupled Plasma Mass Spectrometry (LA-HR-ICPMS) experiments. IRMS was used where appropriate but was hindered in some instances by contami- nated (adhesive) surfaces, limited sample size or plasticizer in (PVC) backing material that was partly extracted upon removal of the adhesive layer. In general, earlier tape comparison results were confirmed and con- clusions strengthened using these more discriminating techniques. Some tape samples were discriminated. If possible, material composition results were combined with physical fit investigation results and led to stronger conclusions.

Bullet fragments and traces were successfully linked together or to specific bullets in shooting incident reconstructions (*i.e.* shoot-out in bar with police officers). If fragments are large enough elemental composition was measured with Inductively Coupled Plasma Atomic Emission Spectrometry (ICP AES). Lead isotope ratios (LIR) are used for bullet traces (*i.e.* lead trace on buckle or window). In a background LIR ICPMS and ICP AES study on 24 Dutch NFI collection bullets (9 mm FMJ) all bullets were discriminated using LIR alone.

Ink and paper forensic investigations become more important because of *i.e.* terrorism aspects such as threat letters to prominent public figures. LA-ICPMS is used for ink comparisons. In the ablation process a combi- nation of ink/paper is ablated and differences in the process are observed using different paper substrates. Most of the elemental spectrum is domi- nated by the paper elemental spectrum. In general, only a few elements will be characteristic for the printer ink. These characteristic elements vary between inks and may partly be attributed to the printing process itself. Using (LA-)ICPMS good discrimination is obtained in paper investiga- tions. IRMS is also a very important technique to discriminate paper. The combination of (LA-)ICPMS and IRMS again is a

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powerful strongly dis- criminating set of forensic techniques.

Insulation layers of electricity cables and polypropylene rope mate- rials were investigated using LA-ICPMS and IRMS after visual and FT-IR investigations were unable to discriminate between samples. LA-ICPMS sufficed to discriminate between cable insulation samples and a combi- nation of LA-ICPMS and IRMS investigations was used to polypropylene rope materials. Polyethylene jerrycan remains in arson residues from various arson investigations were compared using LA-ICPMS and IRMS to establish links between investigations.

Polymers, ICPMS, IRMS

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