B6 (GC-)IRMS Applications for Jeans and Motor Oil Investigations

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After attending this presentation, attendees will have gained an appreciation of the strong potential of (GC-)IRMS for forensic investigations.

This presentation will impact the forensic community and/or humanity by demonstrating new, interesting forensic applications of the IRMS isotopic techniques that have been developed and are demonstrated to result in much more strongly discriminating methods for forensic applications.

Introduction: IRMS is based on measuring very exactly isotope ratios for the lighter elements. The ratios of these elements vary geographically and are also influenced by chemical, physical, and biological processes. This variation offers potentially extra characteristics in the forensic characterization and comparison of materials. Forensic IRMS-applications in general are still in their infancy. In this presentation some initial results are presented for IRMS method development for blue jeans investigations and (GC-)IRMS analysis of motor oils.

Blue jeans: Fibers are important contact microtraces and as such investigated in forensics. Presently for blue jeans, only fiber class characterization investigations are made and no blue jeans fiber comparison is performed as for other fiber investigations. Similar to LA ICPMS, it may be possible to use a technique such as LA-IRMS for comparison of single fibers.

To explore the potential of a LA-IRMS method development, as a first step 24 samples of 20 used blue jeans were analyzed by EA-IRMS (δ^2H, $\delta^{13}C$ and $\delta^{18}O$, separate triple measurements for each sample). Jean samples are denoted by J1-J24 and brands used were Blue Ridge (Hij), Calvin Klein, Calzoni, (Holland design), Capsize rough choice, Jinglers, Laura, Levi Straus 501, NAF NAF, Palomino as well as some unmarked brands. Mean results of triple measurements are presented.

In these analyses EA-IRMS results vary widely with relatively large standard deviation (s) values (range, in brackets s-values): δ^2H - 13.6:-62.6 (1.4), $\delta^{13}C$ -24.78:-26.31 (0.09), $\delta^{18}O$ 25.13:38.30 (0.18) (‰). Most samples are discriminated in this way.

The high discrimination obtained in this experiment demonstrates the high potential of a LA-IRMS application for blue jean fibers.

Motor oils: The characterization of hydrocarbon mixtures using GC-IRMS is of interest for various forensic areas: the characterization of motor oil as e.g. transferred in hit and run incidents when a car drives over a body, the comparison of weapon oil as transferred in gun incidents, the environmental forensics investigation of oil spills and migration through the soil and lastly comparison of hydrocarbon mixtures in arson residues with suspect accelerants from a suspect.

To explore the potential of a GC-IRMS method development, as a first step, 23 different samples of nine motor oil brands and types were analyzed by EA-IRMS (δ^2H and $\delta^{13}C$, separate triple measurements for each sample). Motor oils are denoted by M1-M23 and types used were from the brands Shell (Helix Plus, Helix Super and X100 Super), BP (Visco2000), Total (Quartz 5000), Valvoline (Turbo V), Castrol (GTX Magnatec), Gamma (Extra), and Elf (Competition STI). Mean results of the triple measurements are presented.

The EA-IRMS results vary widely with smaller standard deviation values than for the jeans: δ^2H -92.0:-128.5 (0.6), $\delta^{13}C$ -26.55:-29.71 (0.03) (‰). For most products (motor oils from the same brand and type) a clustering of results could be observed such as for Shell Helix Super, Shell X100 Super, or BP Visco 2000. An exception appears to be Castrol GTX Magnatec with a high inter sample variation. Further experiments will be required to investigate e.g. links with variation between production batches.

Motor oil aliquots were applied to white cotton materials, then extracted using petroleum ether simulating e.g. motor oil sample collection from a T-shirt after a hit, and run incident. The extracts as well as dilutions of original motor oil samples were analyzed for $\delta^{13}C$ using a GC-IRMS instrument. Chromatographic results for two duplicate experiments using a Shell X100 Super motor oil demonstrate the repeatability of the experiments. For data processing the chromatogram was divided into four segments that were integrated separately and converted into $\delta^{13}C$ values. In this way four motor oil 'fractions' are created for which the $\delta^{13}C$ values were determined. Therefore representation of all hydrocarbon compounds is not attempted but integrated values, used.

EA-IRMS measurements for both the jeans and motor oil samples were performed at Iso-Analytical Ltd (Sandbach, UK) without further sample preparation. The IRMS used was a Europa Scientific Geo 20-20 instrument. GC-IRMS measurements were performed at TNO-NITG (Utrecht, The Netherlands) using a Thermo Electron Delta Plus XP GC- IRMS instrument.

IRMS, Motor Oil, Jeans

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