Results indicate that four of these five factors affect the δ values of the product, thus rendering discrimination of MDMA by synthetic route more difficult. Full results and conclusions from both of these studies will be presented in this talk.

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Establishing links between explosives precursors and products using isotope ratio mass spectrometry

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Isotope Ratio Mass Spectrometry (IRMS) has been widely used in the fields of geochemistry and hydrology. The potential for accessing information, such as sample origin and history, have seen IRMS being adopted for a variety of forensic applications. The pharmaceutical and drugs industry have utilised IRMS for establishing patent infringements and characterising batches of illegal drugs. The technique has also been used to investigate human tissue, including hair and nails, to establish information about geographical movement, and has assisted in several murder investigations. The Forensic Explosives Laboratory (FEL) has developed methods for carbon, nitrogen, and oxygen isotope analysis and applied this to samples with explosives significance. Part of the FEL's IRMS research effort has focused upon establishing stronger links between precursor materials and synthesised explosives products. Future applications of this research could involve establishing chemical links between precursors and the explosives products synthesised at an improvised 'bomb factory', for example. While circumstantial evidence of illegal manufacture of explosives may be strong due to equipment, literature, and chemicals found, the addition of a chemical link may complement existing evidence when presented in court. The initial research considered the Woolwich synthesis of RDX, and demonstrated the existence of chemical links between the precursors and product, but also improved the understanding of where direct links might be expected in other reaction schemes. The formation and cleavage of bonds in any reaction affects the direction of isotope change. An understanding of a reaction scheme enables predictions about directions of isotopic change between precursor and product resulting in broad discrimination of potential precursor materials. Despite the very encouraging results of the RDX research, this scenario is relatively unrealistic within the context of UK casework, but was a useful proof of concept. The synthesis of HMTD has been observed in several cases in the UK, and was selected as the target material for a second study. Several batches of HMTD were synthesised at FEL for isotope analysis. The results of this investigation are also presented.

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Contribution of isotope ratio mass spectrometry to the investigation of improvised explosives: Isotopic study of black powders and ammonium nitrates

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The establishment of legislative rules about explosives in the eighties has reduced the illicit use of military and civilian explosives. However, bomb-makers have rapidly taken advantage of substances easily accessible and intended for licit uses to produce their own explosives. This change in strategy has given rise to an increase of improvised explosive charges, which is moreover assisted by the ease of implementation of the recipes, widely available through open sources. While the nature of the explosive charges has evolved, instrumental methods currently used in routine, although more sensitive than before, have a limited power of discrimination and allow mostly the determination of the chemical nature of the substance. Isotope ratio mass spectrometry (IRMS) has been applied to a wide range of forensic materials. Conclusions drawn from the majority of the studies stress its high power of discrimination. Preliminary studies conducted so far on the isotopic analysis of intact explosives (pre-blast) have shown that samples with the same chemical composition and coming from different sources could be differentiated. The measurement of stable isotope ratios appears therefore as a new and remarkable analytical tool for the discrimination or the identification of a substance with a definite source. However, much research is still needed to assess the validity of the results in order to use them either in an operational prospect or in court. Through the isotopic study of black powders and ammonium nitrates, this research aims at evaluating the contribution of isotope ratio mass spectrometry to the investigation of explosives, both from a pre-blast and from a post-blast approach. More specifically, the goal of the research is to provide additional elements necessary to a valid interpretation of the results, when used in explosives investigation. This work includes a fundamental study on the variability of the isotopic profile of black powder and ammonium nitrate in both space and time. On one hand, the inter-variability between manufacturers and, particularly, the intra-variability within a manufacturer has been studied. On the other hand, the stability of the isotopic profile over time has been evaluated through the aging of these substances exposed to different environmental conditions. The second part of this project considers the applicability of this high-precision technology to traces and residues of explosives, taking account of the characteristics specific to the field, including their sampling, a probable isotopic fractionation during the explosion, and the interferences with the matrix of the site.

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Targeting amino acids in latent fingermarks using bioconjugated gold-citrate self-assembled monolayer nanoparticles

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Antibodies that are enantiospecific to l-amino acids have been trialled as a novel antigenic fingermark enhancement reagent. When conjugated to gold nanospheres and placed in a non-aqueous suspension, the antibodies targeted free amino acids and peptides present in fingermark ridge detail with high specificity and sensitivity. Double-antibody sandwich enzyme-linked immunosorbent assays (ELISA), scanning electron microscopy (SEM), and fingermark samples on porous and non-porous surfaces were used to determine the specificity and sensitivity of the conjugates. Trials using fingermark samples developed with the conjugates and enhanced with a fluorescently tagged secondary antibody indicated that the method was most effective for dry and aged fingermarks on non-porous surfaces. The long wavelength fluorescent dyes selected for these experiments addressed issues associated with