



Isotope Ratio Mass Spectroscopy

Is analysing samples by combustion to produce CO_2 and N_2 peaks which are isotopically representative of the parent material. These gas peaks are analysed by IRMS yielding isotope ratios. Isotope abundance is expressed using the δ -notation relative to a reference signal derived from an internationally certified standard of known isotopic composition.

Isotopic variations occur due to biological, biochemical and chemical processes. As a result, a sample will yield a unique isotopic signature thus providing information about its origin. The combination of slight variation in concentration of these isotopes leads to significant discriminatory power between samples.

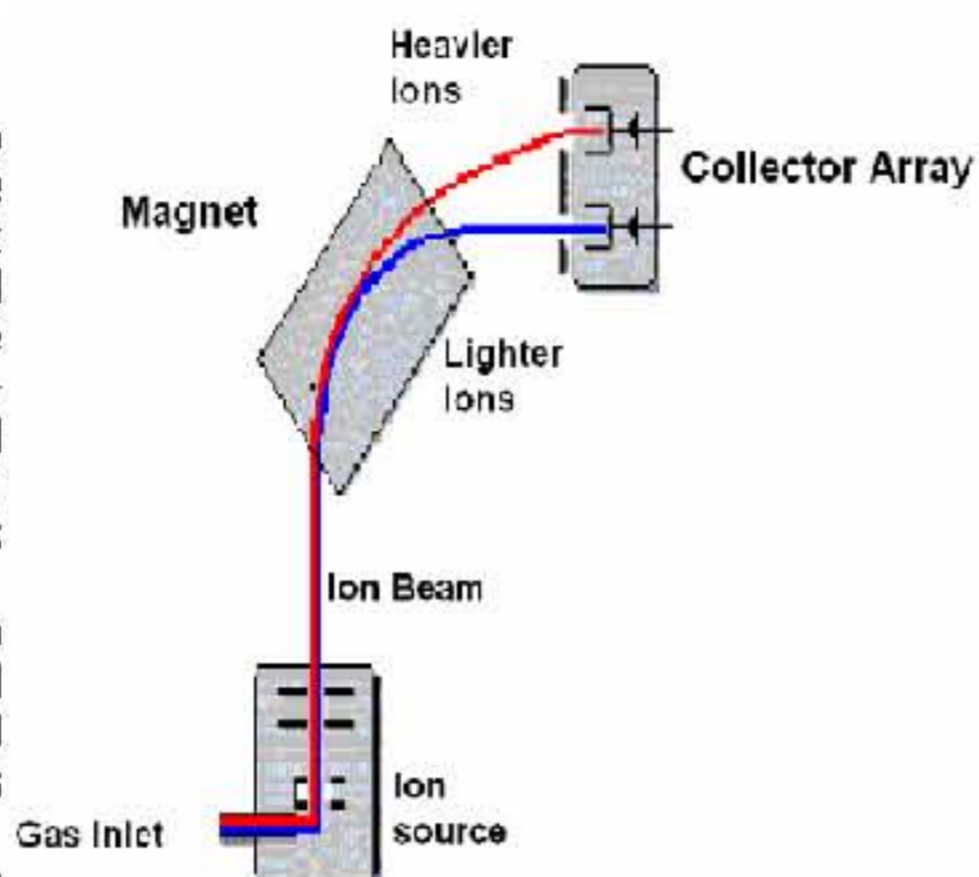


Figure 1 – Simplified diagram of an IRMS

RESULTS

White Paints

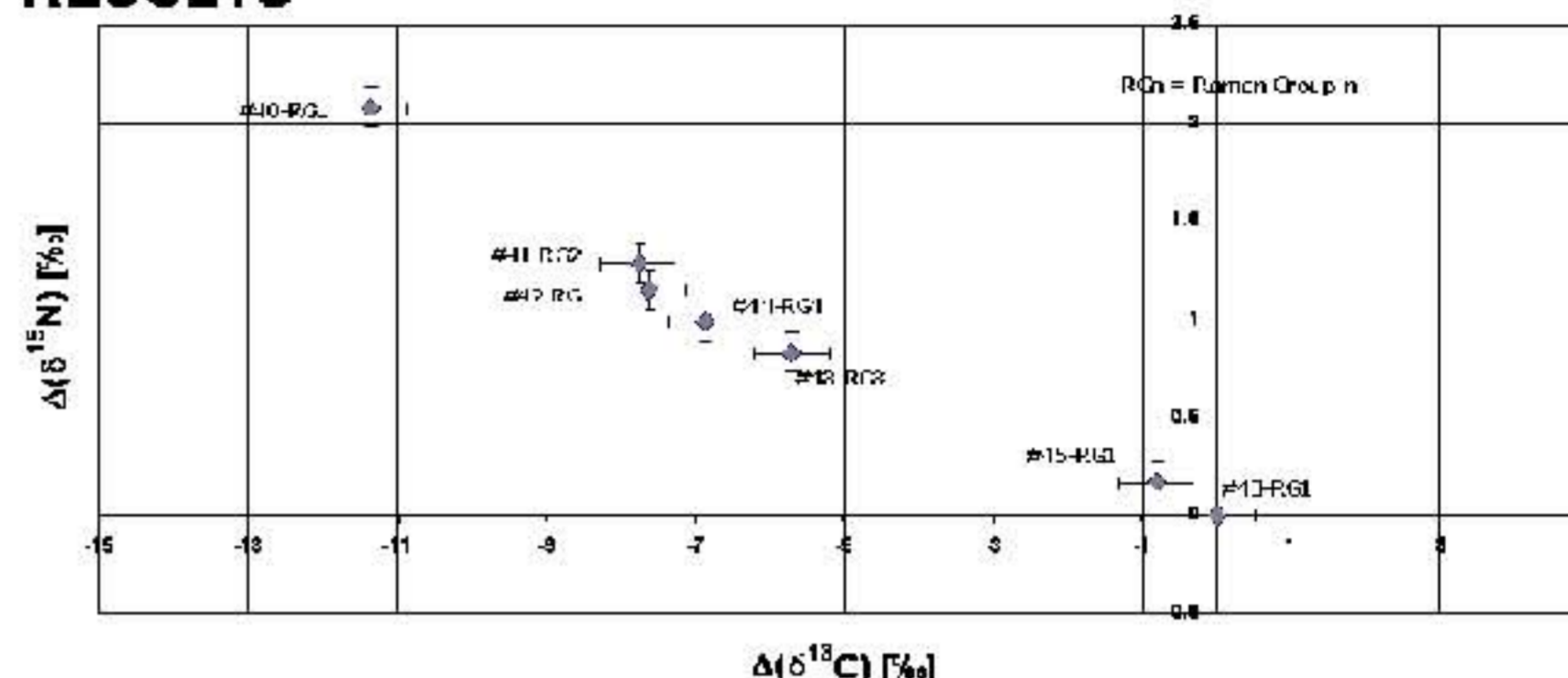


Figure 3: Two dimensional plot of relative ^{13}C and ^{15}N isotopic composition of white paint samples. - Isotopic abundance is expressed relative to the value of sample 48 to illustrate the differences between individual paint samples($n=3$). Spectroscopic grouping according to Raman data was provided by Louise Fido#1

These preliminary results show that it is possible to distinguish between some paint samples where Raman data is not conclusive and vice versa. Consequently when IRMS and Raman are used in conjunction a greater discriminating factor for the use in forensic samples is achievable.

The paint used in this experiment required vigorous stirring which accounted for the 10 min value (blue diamond). This paint was further left for three hours and then painted and analysed (pink circle). These two values were identical at a 95% confidence interval.

As a provisional conclusion if the paint is stirred as directed then this will give an accurate representation of the overall ^{13}C content. Even when left for up to 3 hours after having been stirred properly the isotopic ^{13}C does not change significantly.

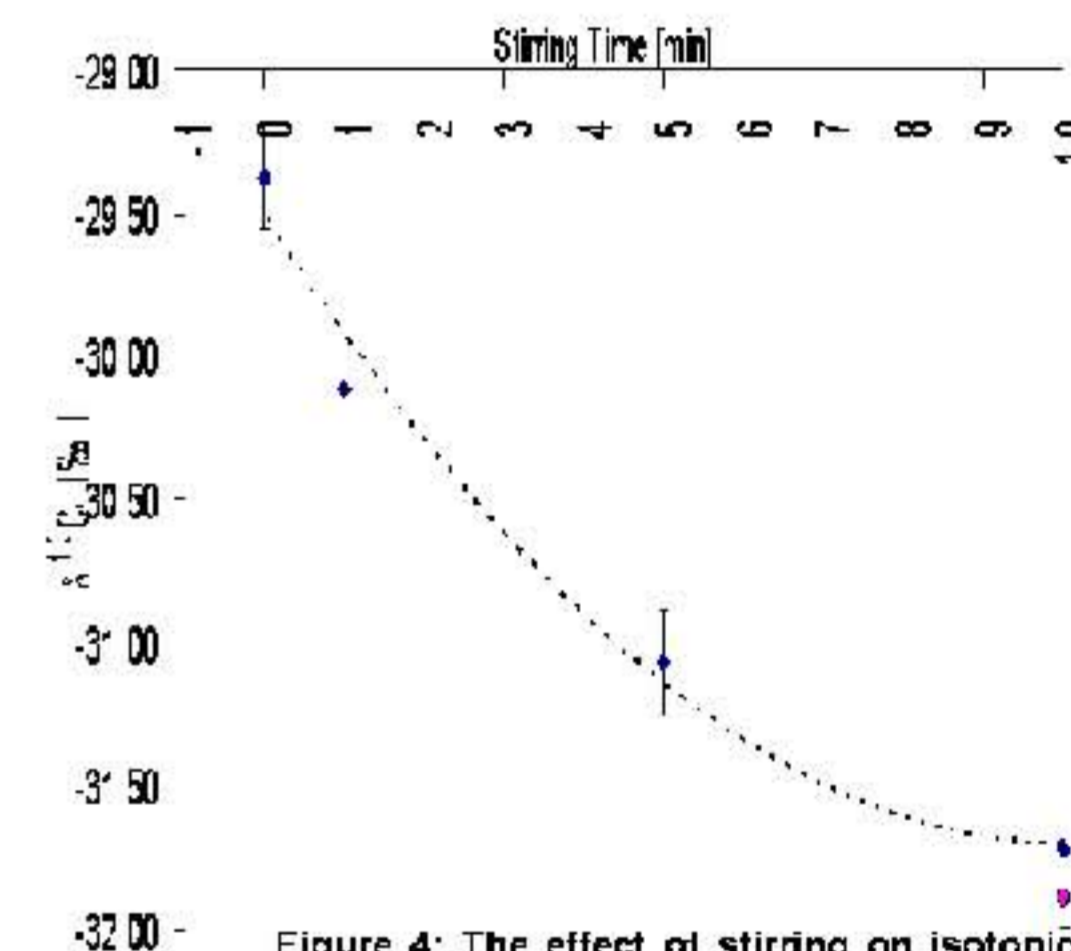


Figure 4: The effect of stirring on isotopic composition of ^{13}C on a white paint sample ($n=3$)

Conclusion and further investigation

The result of this provisional study conclude that the use of IRMS on paint, when used in conjunction with other methods, may provide a greater degree of discrimination between samples.

The application of the paint in regards to mixing is an important factor when analysing the isotopic signature of the sample. One would assume that correct instruction where followed during application.

Further work is being undertaken to investigate whether the thickness and curing of the paint affect the isotope ratio. In addition ground paint samples are currently being analysed to determine whether this also affects the profile.

Acknowledgments

Note added in proof. Further subelement analysis using first derivatives with Raman allowed greater differentiation between samples.

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Paint composition

• **Resin** Film forming portion of the paint. Forms the solid constituent of the dry paint film.

• **Solvent** Disperse the resin which allows formation of the film.

• **Pigment** controls opacity, UV protection of colouring, control viscosity, levelling and sheen.

• **Additives** composed of fungicides and fillers.

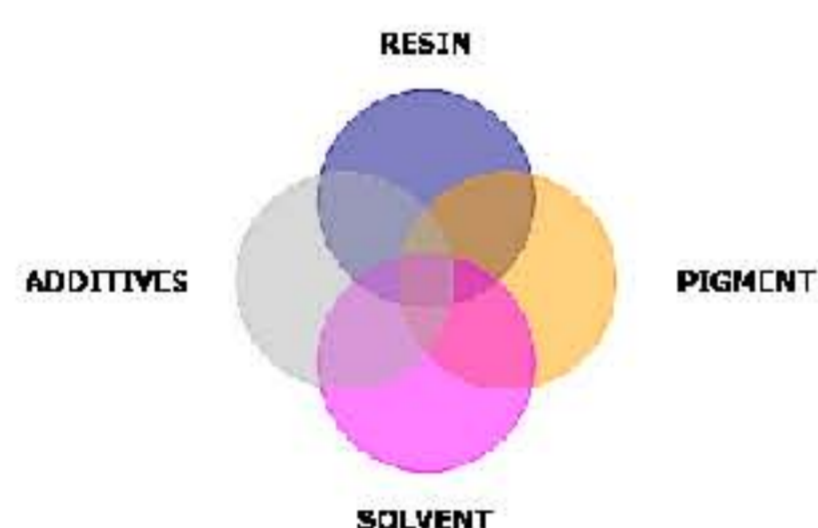


Figure 2 Chemical composition of paint

Due to manufacturing process being different this will lead to a difference in isotopes composition of the paints and hence distinguish between samples to a greater degree of certainty.

Method

10 white paint sample were obtained from Forensic Science Northern Ireland and were painted onto glass slides. These were left to dry in a fume hood for 1 month. Each was then removed and weighed into tin capsules in triplicate. These were analysed using EA IRMS. Isotope ratio were determined for $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$.

One standard paint was used and then stirred under these conditions; no stir, 1 stir, 5 min of stirring, 10 min of stirring, 10 min of stirring and then left for 3 hours. Each was then painted onto glass slide and analysed as above.