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innovators in isotopes

Data bulletin – Significant improvements in sensitivity in IRMS measurements

The sensitivity of an IRMS instrument is a measurement of the sample input vs the signal observed and is calculated in molecules / ion. Sensitivity depends on a number of factors – the trap current (the number of electrons per second entering the source), the number of collisions between the electrons and the sample molecules, and the efficiency of extracting the ions produced.

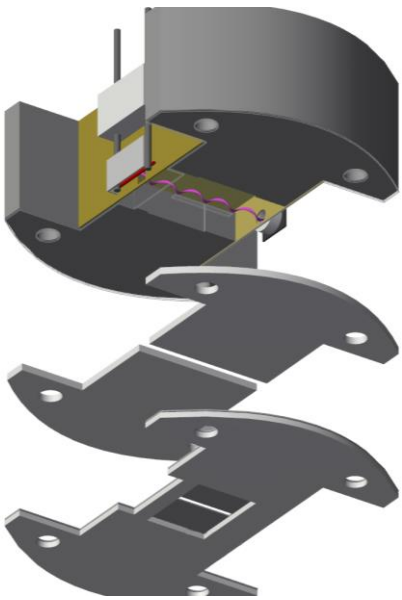

Figure 1. A depiction of the Sercon source, showing the source block, the focussing plates, and the helical path the electrons take as they travel from the filament to the trap

Improved sensitivity allows researchers to measure smaller samples, this is hugely important when sample volumes are limited, or when separation techniques used during sample preparation have reduced the amount of material available for IRMS analysis. Improved sensitivity also leads to greater measurement precision. When running in dual inlet mode it allows measurements to be made over a shorter time, and therefore over a narrower range of source pressures, which improves overall linearity.

Inside a Sercon Nier-type electron-impact source, molecules enter the source block and are ionised by electrons from a thoria-coated filament. These electrons flow from the filament to the trap; the number of electrons produced is controlled by the trap current. The electrons spiral inside a magnetic field created by small permanent magnets inside the source which increases the number of collisions between the electrons and the sample molecules (shown in figure 1).

Typical small radius IRMS instruments have a sensitivity of approximately 850 molecules / ion in dual inlet mode at 600 µA trap current, and their sources are approximately 45% efficient – this low efficiency is due to space charge expansion inside the source box, inefficient extraction of the ions produced, the loss of ions as the beam passes through focusing lenses, and slight beam spread as the ions travel through the magnet to the detectors.

Recent work at Sercon has optimised the design of the source, to improve the efficiency and sensitivity. We have optimised the gas flow through the source, investigated the role of the source magnets, and efficiently matched the source emittance and magnet acceptance windows, ensuring that the ions produced are focussed and extracted from the source efficiently. This work has studied all of the processes occurring inside the source, including a fundamental reassessment of the ion optics and the performance of the source at different trap currents.

Following this work, we are proud to introduce the Sercon HS2022, the most sensitive small radius IRMS on the market. The sensitivity of the HS2022 is 650 molecules / ion at 600 µA trap current in dual inlet mode (850 molecules / ion in continuous flow mode under the same conditions).

Furthermore, it is possible to work at higher trap currents with no decreased lifetime of filaments, further improving the sensitivity and overall dynamic range.

For further details of this system and other developmental work being carried out at Sercon please contact sales@sercongroup.com