Introduction

Thermal Ionization Mass Spectrometers (TIMS) are capable of generating the highest precision and accuracy in isotope ratio determinations. Low mass bias, accurate mass fractionation corrections, high sensitivity and the absence of isobaric interferences are key contributions to a TIMS performance. However, the ability to quantitatively measure ion currents in the picosecond range with minimal calibration are essential ingredients to a precise isotope ratio measurement. We present isotope ratio data obtained from the Phoenix TIMS equipped with new Xact amplifier boards, which demonstrate the current performance levels of a TIMS.

Xact amplifier boards.

The new Xact amplifier boards are mounted within the evacuated and jacketed cooled amplifier housing on the Phoenix TIMS. The boards are also back compatible with the IsoProbe-1, IsoProbe-P and Pacer 54 mass spectrometers.

The board material itself has been designed to be hydrophobic as possible as the presence of residual water in the board material which degasses over time is probably a principal cause of gain instability over time. The resistors have a 25ppm/°C temperature coefficient which is almost 10 times lower than the previous type of resistors which have been in use since the early 1990’s. Since temperature regulation within the amplifier board is kept to <0.00005/°C then the theoretical change in gain would only be 0.5ppm. The amplifier board is permanently mounted using an oil free screw down to minimize any ingress of oil from the pump, and maintain a vacuum of <0.1mbar.

Faraday Noise

The noise levels for different integration times of the new boards are shown in Table 1, for both standard 1e11 ohm resistor and for boards equipped with 1T resistors. In theory the 1T boards should be 3 times quieter than the 1e11 ohm boards, but this is not the case. The 1T boards are typically 1.4 to 1.8 times quieter than the 1e11 ohm boards, with the biggest benefit occurring for 10 second integrations.

Looking at another way the noise characteristics for the 1T resistor for a 10 second integration is the same as a 1e11 ohm resistor for a 40 second integration. In effect for small ion beams you would have to integrate the baseline or the signal four times longer for the 1e11 ohm resistors than for the 1T resistors. This is clearly where the 1T resistors are advantageous.

Conclusions

• New Xact amplifier boards are quiet and fast.
• Gain calibrations are stable enough not to require gain calibration be tween samples or the use of dynamic amplifiers.
• Noise levels of 1T resistors are less than 2 times better than 1e11 ohm resis tors and do not produce significant benefits for nanogram levels of Nd or >100pg of Sr due to the high ionization efficiency of these elements.
• 1T resistors can probably prove advantageous for very small ion beams (<1e-14A) and for transient ion signals.