RGA: MINIMUM DETECTABLE PARTIAL PRESSURE

9mm 3F/301 PIC

INTRODUCTION

RGA instruments have become an invaluable tool in many processes within the semiconductor and biotech industries. As these processes become more complex, the need to analyse them closely with higher accuracy and precision becomes more important. The data obtained can then allow process engineers to make informed decisions on what is happening within their process leading to more efficient systems.

Over the years, significant developments have been made in the electronics of our RGA instruments, for example, in the mass spectrometer interface unit, RF generator and data acquisition boards. These advancements have lead to improvements in the abundant sensitivity and significant reduction in the noise which enables more accurate monitoring of low levels of gas and improved detection limits.

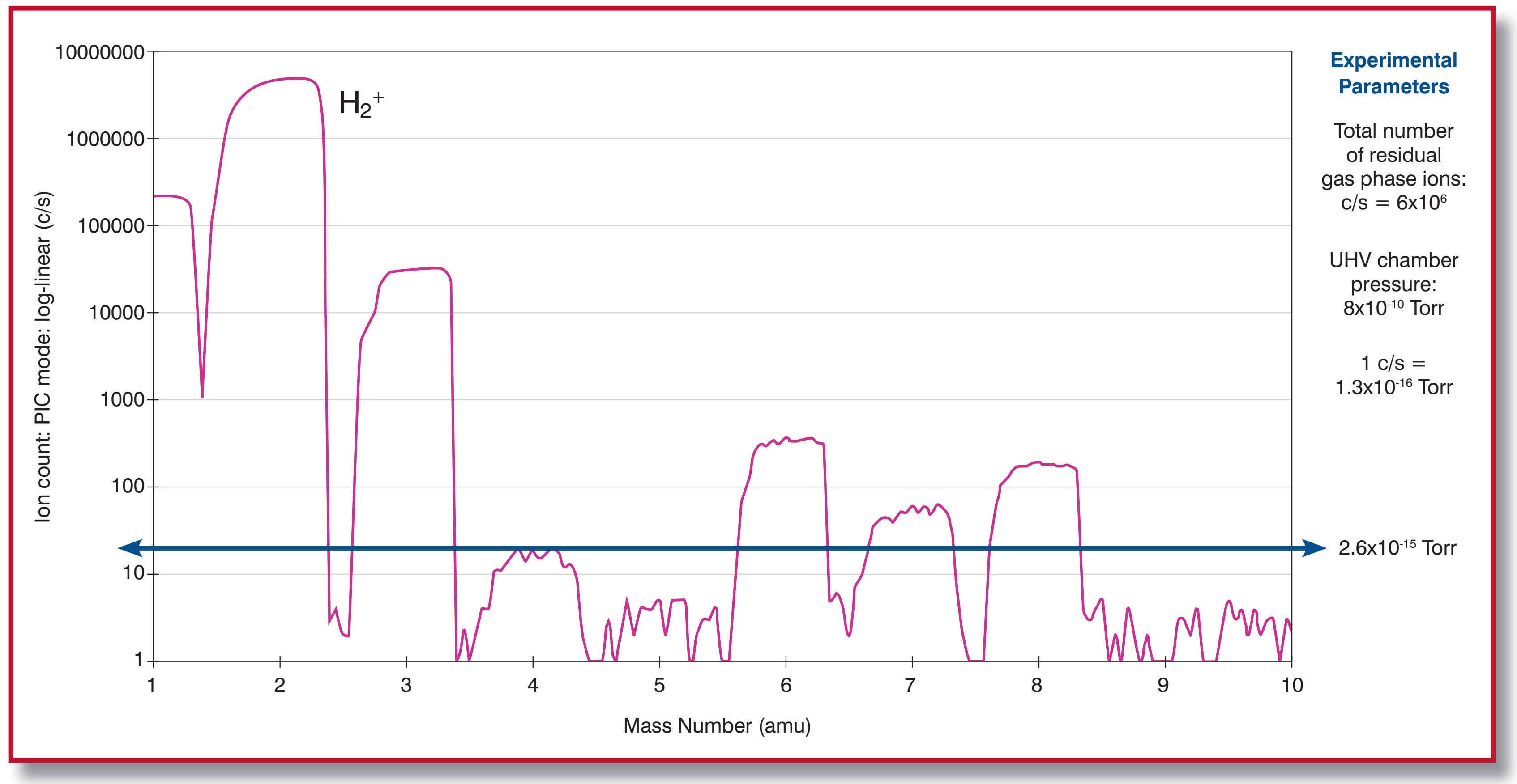

Figure 1: Minimum Detectable Partial Pressure in a UHV environment

DATA ANALYSIS

Figure 1 shows data taken using a 9mm PIC 3F/301 QMS (Pulse Ion Counting, 300 amu mass range). A standard Hiden vacuum manifold and pump set was used to house the QMS, with pre-test vacuum treatments resulting in a total chamber UHV pressure at $8x10^{-10}$ Torr during mass spectra data collection. Ion generation was from a Hiden electron bombardment ion source with an oxide coated Iridium filament.

A typical UHV residual gas spectrum was observed with a major H_2^+ peak present. The 9mm QMS system was operated in ion counting mode, setup to optimise sensitivity while maintaining optimum signal to noise, and a peak width of ≤ 1 amu at 10% of the peak height.

Spectra were acquired from 0-50 amu which, after accounting for ESD and ISD contributions, produced a total residual gas phase count rate of around $6x10^6$ c/s. Count-rates were obtained using a mass scan mode with a dwell time of 1000 ms per data point.

It has been shown that the (m/e) = 2 peak $(H_2)^+$ in the RGA mass spectrum is generated from gas phase ions at UHV, and hence representative of the real residual gas partial pressure in the UHV system, there is virtually no contribution from electron stimulated desorption (ESD) sourced $(H_2)^+$ ions at UHV pressures [1,2].

Effects from ionisation stimulated desorption (ISD) ions can also be discounted as this type of ion is generally only produced in any significant number when the introduced gas phase incident ion is of high mass and with high yield (i.e. relatively high gas pressures). It has been shown there is no ISD contribution to gas partial pressures when low mass species such as H_2 or He are introduced to a UHV environment, unlike higher mass species such as Ar, when ISD effects must be considered [3].

From figure 1, the residual gas major H_2^+ peak at 2 amu is present at a count rate of $5x10^6$ c/s. The H_2^+ mass peak is used as a demonstrator as it is indicative of virtually the entire bulk composition of the residual gas in the UHV vacuum. A simultaneous minimum count rate at 1 c/s can be observed between peaks, corresponding to a minimum partial pressure of around $1.3x10^{-16}$ Torr.

To confidently differentiate a mass peak from the background it is necessary to allow for a step change in signal level of around x3. Thus, from figure 1, it is clear that mass peaks can be resolved from the background noise at around $5x10^{-16}$ Torr partial pressure. For example, the clearly defined mass peak at 4 amu in the spectrum of figure 1 is identifiable at a corresponding gas phase partial pressure of ≤ $2.6x10^{-15}$ Torr.

CONCLUSION

Data taken using a 9mm PIC 3F/301 QMS (Pulse Ion Counting, 300 amu mass range) examines a typical RGA spectrum to determine the minimum detectable partial pressure in a UHV environment (≤ $1x10^{-9}$ Torr). Using a standard Hiden Analytical, oxide coated Iridium electron bombardment ion source with a pulse ion counting detection system, minimum detectable partial pressures are attainable to ≤ $2x10^{-16}$ Torr.

[1] *F. Watanabe, M. Suemitsu, J. Vac. Sci Technol. A* ***17(6)****, 3467 (1999)*

[2] *N. Takahashi, K. Yanagishita, T. Hayashi, H. Akimichi, Y. Tuzi, App. Surface. Sci* ***169-170****, 752-756 (2001)*

[3] *S. Kurokouchi, S. Kato, J. Vac. Sci. Technol. A* ***19(6)****, 2820, (2001)*

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