Degassing Bayard-Alpert Ionization Gauges

Introduction

The cleanliness of an ionization gauge has a considerable effect on its performance.

To reduce the outgassing in a Bayard-Alpert gauge (BAG) to a negligible level, and minimize the effects of electron-stimulated desorption (ESD) on low pressure measurements, the outgassing technique known as "**Degassing**" is often employed to drive off the gas molecules adsorbed on the anode grid structure. During degas the electrodes are degassed by heating to a temperature of 900°C (nominal) for 10-20 minutes. The electrode heating is accomplished by either electron bombardment (**EB Degas**) or by passing a high current through the grid (**I^2R Degas**) .

Note

EB Degas, with user adjustable power and time settings, is standard in all **IGC100** controllers.

In conventional gauges, and particularly those manufactured in the US, the anode grid is in the form of a single or double helix designed to allow a current to be passed through to provide ohmic heating. Distortion and sagging can occur here if the temperature attained during degassing is too high. Modern gauge heads use molybdenum or tungsten grids to avoid or minimize this problem. Typical powers used during resistive heating degassing are about 70 Watts (7Vdc @ 10 A). All helix gauges can also be degassed by EB as well.

Gauges made with squirrel-cage grids (UHV-extended nude BAGs) can accept only EB degas. During EB degas, the grid (and sometimes the collector as well) are biased at around 500V and bombarded with electrons from the filament (biased at 30Vdc). An emission current of a few tens of milliamps is sufficient to heat the electrodes (usually molybdenum) to a dull red. The combination of heating with the electron bombardment of the electrodes provides a very effective cleaning procedure.

Degassing is best carried out, while the rest of the vacuum system is also being baked to avoid degassing products from adsorbing onto the walls of the chamber.

It is common practice for many HV users to automatically degas the gauge and/or bake the vacuum system after the gauge is exposed to ambient, or after surface contamination is suspected. BAGs will be unstable for several hours following degassing until the chemical composition and adsorbed layers on the newly cleaned surfaces reach equilibrium. This effect must be carefully considered for high accuracy determinations.

All commercially available BAGs can be degassed by electron bombardment. However, thoriated filaments can be rapidly damaged by the intense ionic bombardment that they experience when EB degassing takes place at pressures above 10^{-5} Torr. To extend filament lifetime, minimize the emission current during degas and extend the degas time to compensate.

Some vacuum researchers[i] suggest bombarding the collector wire along with the anode grid during EB degassing. This approach leads to clean electrodes, but it is intrinsically dangerous in practice. Instead, it is recommended to keep the collector connected to the electrometer to get a rough estimate of the pressure during degas. EB degassing at pressures $>5 \cdot 10^{-5}$ Torr can damage the gauge, and hurt the user if the vacuum chamber is not properly grounded.

Note: The **IGC100** controller automatically checks the pressure in the vacuum system before degassing can take place. Degassing does not proceed if the initial pressure in the system is $>5 \cdot 10^{-5}$ Torr. An approximate pressure reading is provided during degas, and the degas power is automatically adjusted to keep the pressure below the safe level if the pressure readings exceed the $2 \cdot 10^{-5}$ Torr threshold. The remaining degas time is displayed on the front panel throughout the entire degas process. For added flexibility, the **IGC100** provides user adjustable degas time and power settings.

Recommendations

The **recommendation** from the **NIST High Vacuum Group**[ii] is to eliminate degassing by high temperature heating of the grid (whether resistive or electron bombardment). For baked systems, their observation is that gauges can be effectively outgassed by simply operating them at normal emission currents while the BAG and vacuum system are baked. For unbaked systems, the gauge can be baked and outgassed by thermally insulating it with fiberglass. Degassing by electron bombardment is only recommended if (1) the gauge is heavily contaminated or (2) after exposure to surface active gases such as O_2. Whenever possible minimize the emission current during degas and extend the degas time to compensate.

MICRO-ION® Gauges

For specific information on the proper degassing of MICRO-ION Gauges (Granville-Phillips, Longmont, CO, USA) consult the “Using the IGC100 with MICRO-ION® Gauges” application note.

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[i] See for example: B. R. F. Kendall, “ Ionization gauge errors at low pressures”, J. Vac. Sci. Technol. A 17 (4) (1999) 2041.

[ii] C. R. Tilford, A. R. Filipelli and P. J. Abbott, “Comments on the stability of B-A ionization gauges”, J. Vac. Sci. Technol. A13(2) (1995) 485. See comments on second column of p. 486.