

TECHNICAL NOTE

Benefits of RGA Degassing

DEGAS EFFICIENCY: INTRODUCTION

In the last 20 years, Residual Gas Analyzers (RGAs) have evolved from the laboratory to become powerful analytical instruments. This Technical Note examines the degas process used in RGAs. Even the most chemically “inert” metals are to some degree “active” in the sense that gasses and liquids (even solids, in the case of mercury and silver) will diffuse into their lattice. When this process occurs on metal surfaces, it often falls into two categories: physisorption or chemisorption. Physisorption is a thin layer of adsorbed vapor molecules held to the surface of a solid by relatively weak intermolecular (van der Waals) forces. Chemisorption is the formation of a single layer of adsorbed molecules onto an adsorbent surface that are held by chemical bonds. Filaments used in RGAs, whether made of Tungsten or some form of Thorium or Yttrium coated Iridium, are susceptible to adsorption of gasses.

GENERAL CVD CONSIDERATIONS

Since the chemistries of many CVD and Etch processes form conductive deposits on insulators, precautions must be taken to minimize the decomposition products from the hot filament. These decomposition products, often electrically conductive, will be deposited on insulating surfaces that are in “line of sight” geometry with respect to the filament. These conductive deposits can cause small current leakages that will create shorts that could cause an emission fault. Alternatively, insulators can be deposited on conducting surfaces that can disrupt the distribution of charges on focusing lenses necessary to guide ions through the central axis of the quadrupole. This change in electric field symmetry reduces the mass discrimination ability of the quadrupole, reducing the RGA sensitivity. In both cases, degassing will remove the contaminants adsorbed onto the interior surfaces of the ion source.

Due to the higher operating pressures encountered in CVD processes, closed ion sources are almost exclusively used. Although great care is taken to choose materials that are

least susceptible to adsorption, such as gold plated stainless steel ion sources and Tungsten filaments, some adsorption occurs. The optimum method to minimize the effect of adsorption is to perform a “bake-out”. A bake-out heats the vacuum areas of concern to a uniform temperature above 100 °C (typically 150 to 250 °C). For INFICON RGAs, this should be performed with the filament on and EM off if hotter than 150 °C (the EM can stay on if the temperature is 150 °C or lower). The bake-out takes a minimum of eight hours followed by a four hour cooling period.

If time does not permit for a bake-out, degassing is another method. Degassing has the temporary effect of cleaning the ion source, while a bake-out will clean the entire “system.” Degassing is accomplished by increasing the current to the filament inside the ion source. This increased current through the filament results in a greater number of electrons leaving the filament, which in turn impinge on surfaces inside the ion source. It is these electron bombardment “collisions” that directly cause heating of the surfaces. Heating of the interior surfaces of the ion source, either by electron bombardment or by radiant heating of the filament, causes contaminants to be liberated.

To minimize signals from unwanted sources, the ion source should be baked-out after the system has been evacuated from atmosphere. Degassing will temporarily clean the ion source if baking is not possible. To verify that no additional contaminants will be produced due to double ionizations and cracking of certain molecules, the electron energy should be minimized to a level that is just sufficient to ionize the gasses of interest. The effect of a typical degassing for a closed ion source (CIS) sampling at atmosphere is shown below for water ($M/z=18$) and air ($M/z=28$):

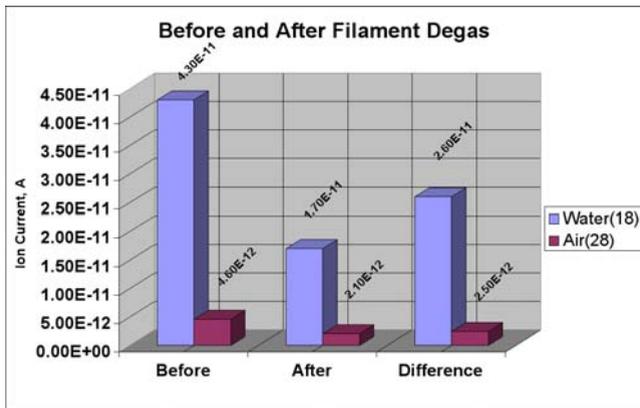


Figure 1

Clearly, the background of these two gasses coming from the ion source volume is reduced significantly. This background reduction allows the RGA to detect lower concentrations of those gasses desorbed during the degassing operation.

The graph below illustrates one drawback of degassing. The effects are often temporary if gasses that were present before degassing continue to adsorb to, and later desorb from, the interior surfaces. Immediately after degassing the levels are seen to increase, but level off to an equilibrium value after several minutes.

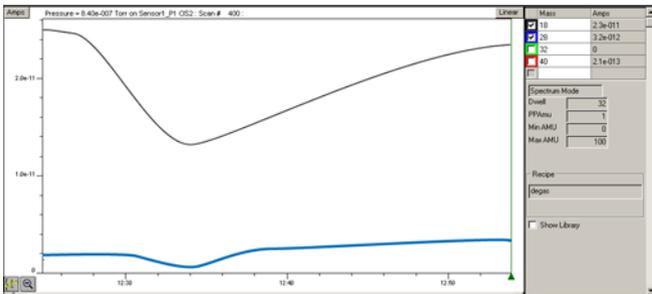


Figure 2

The aim of degassing is to reduce the background by lowering the contribution from the interior surfaces of the ion source. However, the ion source is only one source of contaminants in a typical system. The interior walls of all of the other components are also sources of contamination, which can be reduced by performing a bake-out. A bake-out of the entire system (RGA sensor, inlet, connection piece, etc.) will liberate the unwanted contaminants, which will be pumped out of the system to ensure a more permanent cleaning.

Degassing has an unwanted effect on filament life. Typically, filament life is affected by many factors such as filament temperature, gasses the filament is exposed to, and operating pressure, among others. The increased current flow during a degas cycle raises the temperature of the filament and accelerates the evaporation of material¹, which during normal emission would occur at a much slower rate. This decline in filament life should persuade users to degas infrequently, and only then as a temporary remedy to reduce background until a full bake-out is possible.

The lowest possible system background level can be achieved only with a traditional system bake-out.

¹Increased filament current is not to be confused with electron energy (voltage). Increased current only increases the flux of emitted electrons and not their energy.

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