INFICON

# TECHNICAL NOTE

## Gas Purge and CPM Sensor Lifetime

### INTRODUCTION

Over the last few decades, Residual Gas Analyzers (RGAs) have gone from being diagnostic tools for identifying vacuum problems to becoming powerful analytical instruments used for process monitoring and control. But today's semiconductor manufacturing processes (CVD, Etch, etc.) make use of many harsh chemicals that can, over time, adversely affect the RGA sensor's sensitivity, and thus its useful lifetime.

### SENSOR LIFETIME

The main detractor to sensor lifetime is the life of the ion source. Other than filament life, the ion source lifetime is dominated by sensitivity loss. Sensitivity loss has been traced to the build up of an insulating layer on the surface of the anode cylinder where the electron beam terminates. In most cases, the insulating layer is deposited when electrons strike reactive molecules adsorbed on the anode surface. It is this impinging electron beam that supplies enough energy for the reaction to proceed. The deposition rate for this insulating layer is proportional to the product of the electron emission current and the sample gas pressure. At constant emission current the total amount of deposited material depends on the total dose of the offending material.

### INCREASING SENSOR LIFETIME BY SAMPLE REDUCTION

To improve ion source lifetime in cases where reagents or product gases are particularly troublesome, the CPM inlet orifice should be chosen to allow the least amount of gas into the ion source that still provides the desired detection limits. Standard INFICON orifices are designed to give the capability of detecting impurity levels of or below 1 PPM at the orifice's nominal pressure. Since many applications do not require such low detection levels, using a smaller orifice often does not present a problem. The smaller orifice results in a lower pressure in the ion source, and lower partial pressures of the offending gas species, thus increasing the sensor's lifetime.

### NITROGEN PURGE PROBLEMS

In some applications, RGA sensors have been purged with nitrogen while not monitoring the process in order to displace corrosive gases and surface contaminants in the sensor and help keep the system clean, thereby allowing the system to return to lower background levels faster. Tests show, however, that the background only improves when Ultra High Purity (UHP) Nitrogen is used for the purge gas. Typically, N2 used for the turbo pump bearing purge on CPM systems contains a high level of $H_2O$ that permeates in at joints, O-rings, or through plastic tubing. To avoid this, the purge gas would need to be controlled using a UHP regulator and plumbed into the system using stainless steel tubing and appropriate fittings, thus increasing the burden and cost to the end user.

Another potential issue arises when the CPM system returns to process monitoring after the purge. Wall conditioning must occur in the CPM system in order to get a stable signal and eliminate the first wafer effect. This can happen relatively quickly, in only a few seconds, or it may take several minutes to stabilize, depending on the process. Even if stabilization occurs in only a few seconds, that can be a “long” time in some fast processes, e.g., ALD.

### UHP PURGE GAS

If a purge is absolutely necessary, a source of UHP gas is available on the CPM. An argon only and a CPM Calibration Reference Gas Mixture are existing sources of UHP gas that can be plumbed into the sensor simply and without water-permeation concerns. The CPM calibration reference gas also has some high mass peaks for mass scale calibration. The calibration gas composition is:

- H2 (1%)
- He (1%)
- N2 (1%)
- Ar (Balance)
- Kr (1%)
- Xe (1%)

Consumption of the UHP purge gas can be an issue; however, “Idle” time is rare in a well-used tool, so the actual purging time is short. Occasional flow of this calibration reference does not deplete it to a point that the gas pressure, and therefore leak rate, is compromised, although the “on-time” should be monitored for this reason.

## SUMMARY

The real lifetime limiter for an ion source is loss of sensitivity due to a build up of insulating deposits inside the system DURING process monitoring.

Selecting a smaller diameter orifice will reduce the dosage of offending gases seen by the ion source, thus decreasing the rate of deposition of insulating films in the ion source and increasing lifetime.

An N2 purge is effective only if performed with Ultra High Purity Nitrogen hard plumbed into the CPM system, at the added expense to the end user.

INFICON recommends operating with the sampling system conditioned to the process chamber, without isolation from the process, for rapid response to the gas species of interest.

If baseline reduction or “clearing” of the sensor is desired (e.g., clear HF from EM after NF3 clean), the UHP Argon Only Reference or CPM Calibration Gas Reference may be used as an alternative source of purge gas.

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