

Integrating the Dycor RGA with a Cluster Tool

The Dycor Mass Spectrometer is a versatile instrument that can provide process engineers, as well as equipment and maintenance personnel, in the semiconductor and other vacuum related process industries, valuable information on the state of their process and vacuum equipment.

Commonly referred to as a Residual Gas Analyzers (RGAs), the Dycor Dymaxion RGA, with System 2000 operating software for Windows XP and Vista, can be used for a myriad of applications, and can be configured to match the particular process tool, and extent of automation, the user requires.

Equipment Monitoring

The Dycor RGA can be used for equipment monitoring on multi-chamber process tools to reduce downtime after maintenance and return the tool to production. In this application, the RGA is used to qualify the tool by performing tests which verify the cleanliness (e.g., absence of residual materials such as photo resist), and vacuum integrity (whether the tool is leak tight) of

the tool. This is accomplished through Leak Testing (spraying helium around flanges and connections outside the chamber and detecting any helium that enters the chamber), and conducting Pump Down and Rate of Rise tests. Finally, when the equipment is verified to be clean and at base pressure, the RGA is used to “Fingerprint” the vacuum state for future reference and comparison.

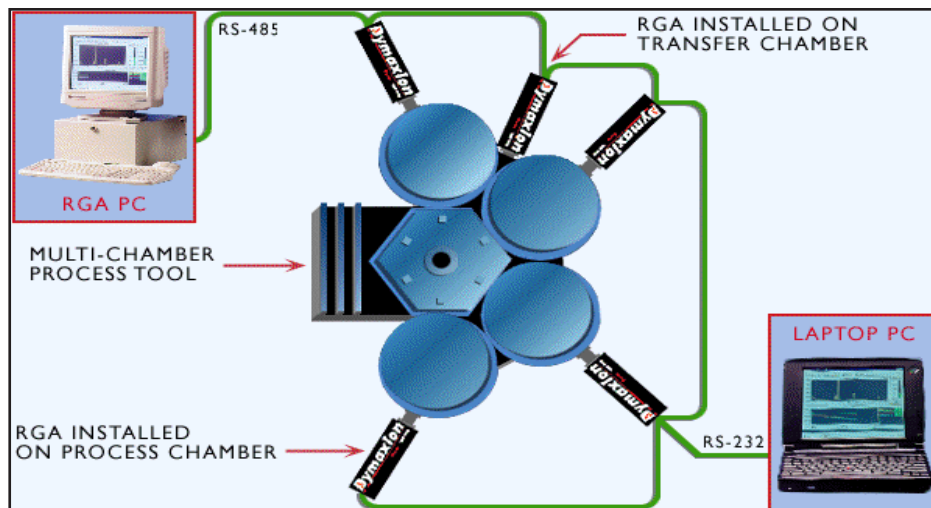
Figure 1 is a schematic showing how the Dycor dymaxion RGA is installed on a multi-chamber tool for equipment monitoring.

In this configuration, multiple RGAs are controlled directly from a PC running the System 2000 software. The RGAs are connected to each other, and to the PC, using an RS-485 loop.

In addition, any of the RGAs can be connected to a laptop PC, for local control through the RS-232 port.

The RGA mounted to the transfer chamber is a 1 - 100 AMU Range instrument with Faraday Cup and Electron Multiplier Detectors. It has an Open Ion Source, which provides the most sensitivity for finding small air leaks when qualifying the tool for return to process after maintenance. Because this RGA is only used when the chamber pressure is below 10^{-4} Torr, no sample inlet is required and the sensor is mounted directly to the chamber via a 2 3/4 inch diameter Conflat flange.

The RGAs installed on the process chambers must be able to operate at pressures in the millitorr range. Therefore, a



Equipment monitoring with the RGA controlled directly from a PC.

Figure 1.

Conductance Limited Ion Source (for PVD), or Enclosed Ion Source (for CVD) instrument, with Pressure Reduction Inlet System is used. Figure 2 shows the type of inlet manifold used on the deposition chambers.

Process Monitoring

With Semiconductor fabs manufacturing 300 mm wafers, with feature sizes less than .25 microns, it is important to have real-time control of processes using RGAs for in situ measurements of gas species. The following are different ways in which the Dycor RGA can interface to a multi-chamber tool.

Direct interface of RGA to Tool I/O

One method for interfacing the RGA to the tool, is a direct connection from the tool I/O module, to the optional Dymaxion I/O board in the sensor electronics unit. This permits data from the RGA to be correlated with the production run data, as well as providing advanced alarm capabilities that protect the process from "out of specification" process events.

A scenario of what might be done with this type setup is given below:

A cluster tool with four process chambers requires that 3 different conditions be met, either before, or during a process run. These conditions are:

- || Prior to process - RGA analog scan indicates if there are any gas partial pressures that are out of specification, air leaks, or contaminants that would prevent the start of a run.

Digital input from the tool to the RGA starts a full analog scan.

Digital output from the RGA to the tool indicates analog scan is complete and any alarm outputs from the RGA are now valid.

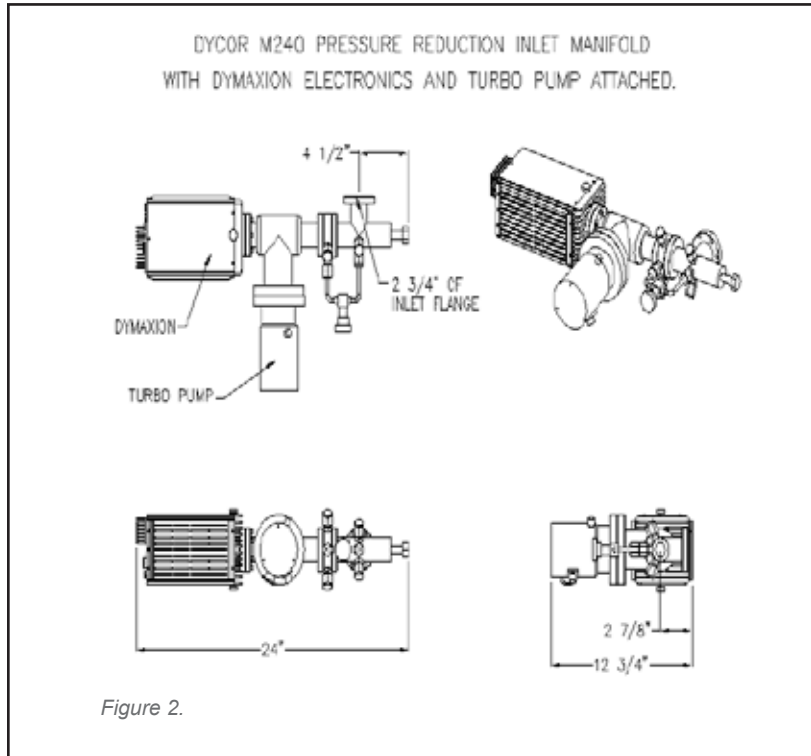


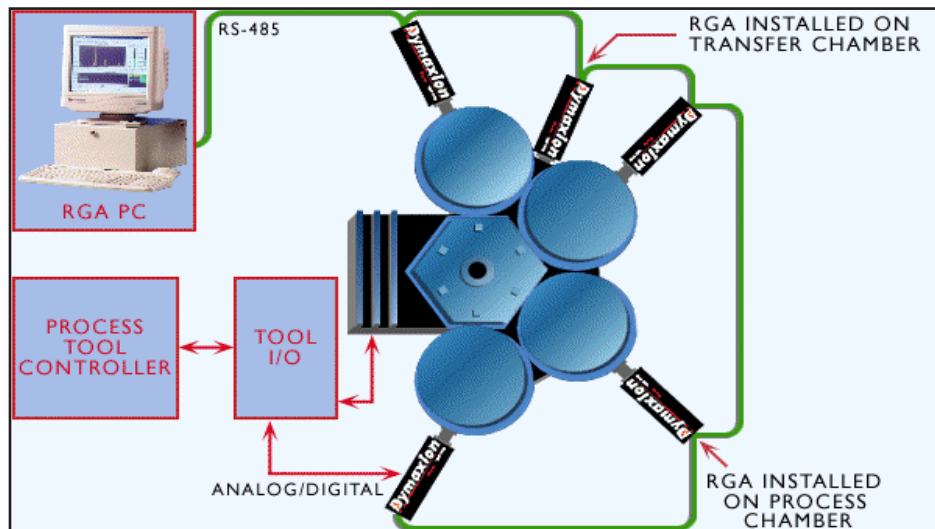
Figure 2.

- || During process - if any gas partial pressures are out of specification, an alarm is activated to stop the process.
- || During process - if any gas partial pressures are out of specification, an alarm is activated to flag an operator. The current run continues, but the next process is not started.

Digital output from the RGA to the tool indicates an alarm condition.

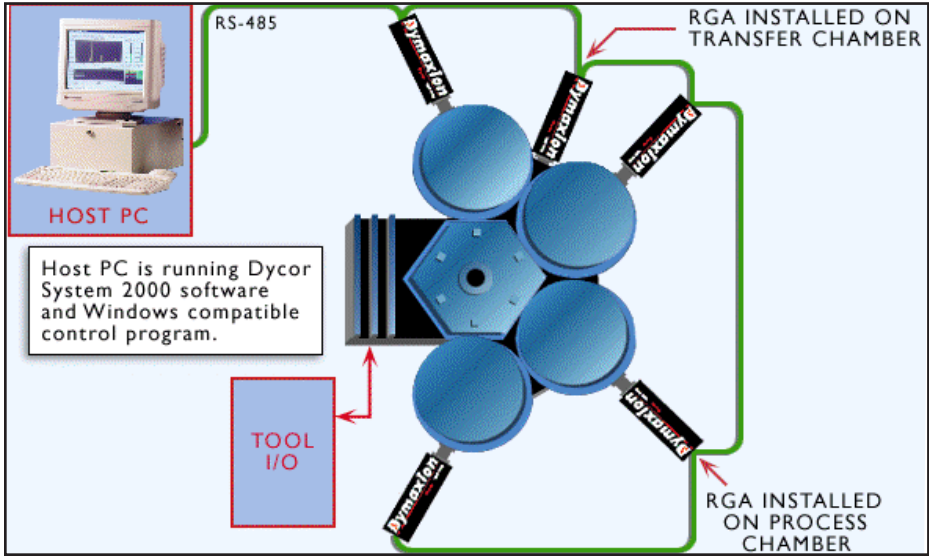
(This could be due to an air leak, indicated by the ratio of the 28 to 32 peaks being 5 to 1)

Digital output from the RGA to the tool indicates an alarm condition.



Direct I/O integration of the RGA with the Process Tool.

Figure 3.



Host PC controlling both the Tool and the RGAs using DDE or OPC automation.
Figure 4.

(This may be due to an increase in hydrogen during the run, indicating the deterioration of the pumping speed of a cryopump that needs regenerated. The process can continue, but the pump should be regenerated prior to the next run.)

A key point in this scenario is that four RGAs, on four different chambers, are running simultaneously and are controlled from one PC. In addition, each chamber is running independently from the others, with its own unique

set of process requirements.

Figure 3 is a schematic showing interfacing directly to a multi-chamber process tool.

Host PC controlling Tool and RGAs

Another method for interfacing the RGA with the Tool is by using a Host PC running both the Dycor System 2000 operating software, and a Windows compatible control software package (e.g., Wonderware, Techware etc.). The PC then communicates to the RGAs by using either Dynamic Data Exchange

(DDE), or OPC Automation. Figure 4 shows such an arrangement.

RGAs integrated to Tool using SECS/GEM Protocol

Alternatively, a SECS or GEM interface protocol may be used for communication between the Tool controller and the RGA PC. Figure 5 shows such an arrangement.

Important Note:

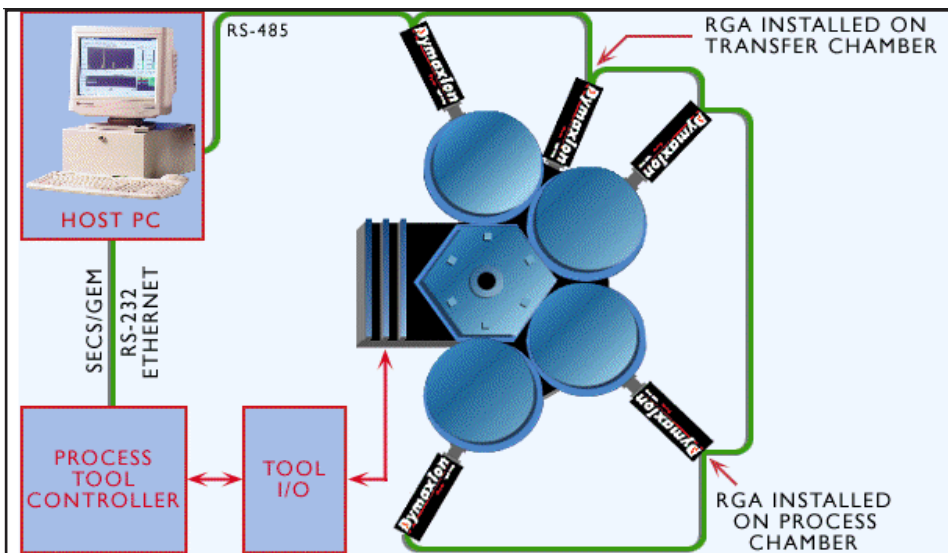
All the advantages of in situ gas analysis using an RGA will be lost if the instrument shuts down the process because of false alarms due to transient events or noise spikes.

The System 2000 software has advanced alarm capabilities, which the process engineer can use to remedy the problem of false alarms shutting down a system.

The user can set a count value such that the alarm limit has to be exceeded a consecutive number of times before an alarm is triggered. This protects the system from short transient events and noise spikes that can trigger false alarms.

Utilizing the Real-time Calculation capability of System 2000, alarms can be set for ratios of two different

gases, or other inputs, providing more system intelligence. For example, rather than using one gas partial pressure, such as oxygen, to indicate an air leak, the ratio of nitrogen to oxygen may be a more reliable indicator. And even more protection from false alarms is provided by a Master Alarm feature which combines two or more individual alarms using Boolean logic (AND, OR, NOR etc.).



RGAs integrated with the Tool using SECS/GEM protocol.
Figure 5.

Figure 5.

Summary

In summary, there are currently no standards in place that can be used to integrate RGAs with semiconductor manufacturing tools, as each user must decide which method best serves their particular needs. In the future, RGA vendors must work more closely with manufacturers of process tools to develop more standard integration techniques.

Dycor currently offers the flexibility and advanced software capability to facilitate integration of the Dycor RGAs with the process tool using a number of different integration techniques, each having their own advantages, depending on the particular application.

Dycor meets the challenge of providing assurance of data integrity, instrument reliability, and software flexibility that translate into increased productivity and higher yields in your fab.



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