Using the Dycor RGA in Solar Panel Production

History

Solar panel production via thin-film deposition processes is increasing at a rapid rate. These second and third generation panels are efficient; small; and the well known thin-film deposition techniques allow for a “roll-to-roll” production process that maximizes throughput and minimizes material overhead.

Depending on the type of film to be deposited (and the substrate) the actual technique can be physical vapor deposition (PVD); chemical vapor deposition (CVD); or plasma-enhanced CVD (PECVD). Regardless of the technique in use, the Dycor RGA is used to provide process information over the wide range of pressures found in these processes, typically 5 Torr to $10e^{-5}$ Torr. This information is crucial for both manufacturing quality and quantity.

In its simplest form, the Dycor RGA is used to monitor the thin-film line during pumpdown. With its high sensitivity and excellent long-term stability, the Dycor RGA is the perfect early warning system for deposition line problems (Fig. 1)”

At the completion of the deposition run, the deposition tool undergoes a preventive maintenance (PM) cleaning process to remove deposits from the walls of the chamber. Following this, offline, post-PM requalification takes place as the tool is pumped down to process operating conditions (Figure 1).

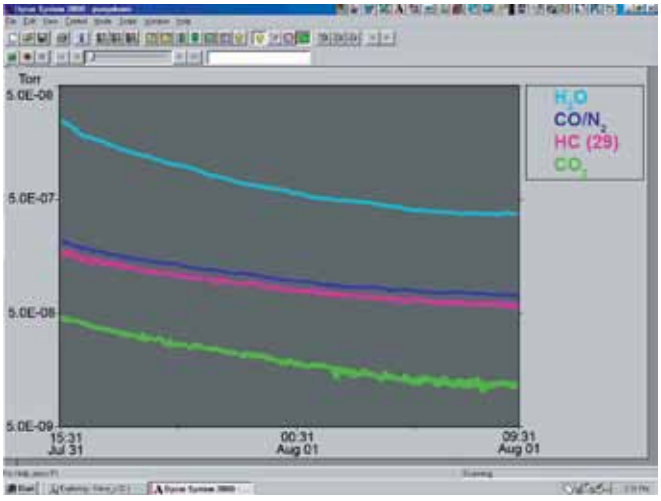

Figure 1. The Dycor Quadrupole RGA can be used to record pumpdowns in the form of partial pressure versus time curves. Pumpdown curves can be used as a reliable early warning system for a variety of vacuum problems.

Why a Quadrupole RGA?

A Residual Gas Analyzer (RGA) can tell you not only the total pressure of the residual gas in the chamber, but also the gas species present and their partial pressures. The Dycor Quadrupole RGA can be used to record these pumpdowns in the form of partial pressure versus time curves. Developing pumpdown curves for different deposition chambers is done by creating baseline data for key gas species present in the chamber (e.g., N_2, O_2, H_2O, and many cleaning solvents). The types of cleaning solvents, the humidity, target changes, cryopump regenerations, chamber hardware replacement, real leaks, and virtual leaks all contribute to the variability in pumpdown rates. By using statistical process control methodology to help characterize these variables, pumpdown curves can be used as a reliable early warning system to inform maintenance personnel of vacuum problems before significant time is lost trying to achieve base pressure. The end result is more time spent making product rather than recovering from preventative maintenance (PM) servicing.

Dycor RGAs

A Dycor RGA is a non-invasive process monitor that can be used to characterize the deposition process by plotting the presence or absence of a particular gas species with respect to time. A “Gold Standard” baseline run is established for the specific gas partial pressures present during process runs. As deposition begins, each run can be compared to this standard (Figure 2). Direct correlation between process runs and the standard indicates whether system conditions are optimized for operation. This provides the benefit of extending operating time between cleanings, ultimately increasing yield. It also quickly detects abnormal conditions or process problems so that corrective action can be taken to minimize product defects. Any process deviations or contaminants that affect yield are detected and signaled through software alarms.

Opto 22 I/O Controller

The Opto 22 digital/analog controller is used to activate the pneumatic valves, receive Transistor-Transistor Logic (TTL) signals from a PLC to take the RGA online or offline, and provide a 0 to 10V analog input for monitoring a total pressure gauge. Additional I/O paths

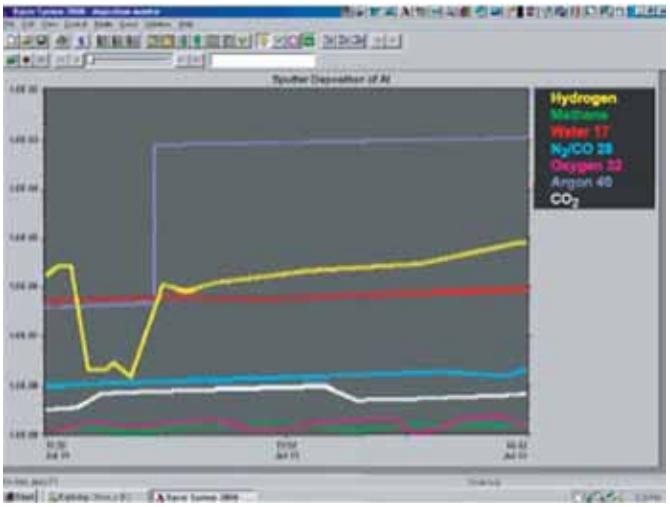

Figure 2. Process monitoring run of sputtered deposition.

are available to allow the Dycor RGA to assume control of the process, initiating process state changes as need.

System 2000 Software

The System 2000 software package automates all processes involving the RGA. Trend mode can be used both during process monitoring and post-PM. In Trend mode, different mass channels, analog inputs, and total pressures can be tracked over time. This mode offers the ability to compare day-to-day runs with the Gold Standard baseline. Conclusions drawn from these comparisons can directly reflect the product quality and yield.

The System 2000 software also has the capability to execute scripts written in Visual Basic that make bringing the RGA "on" and "off" process very easy.

A schematic representation of a Dycor RGA integrated with a deposition tool is shown in Figure 3. The pressure reduction inlet system comes with an electropneumatic high conductance valve for use during post-PM requalifications, and an electropneumatic bypass valve with an aperture sized for sampling at process pressures. Switching between either of these sample paths is automated by software control of each valve.

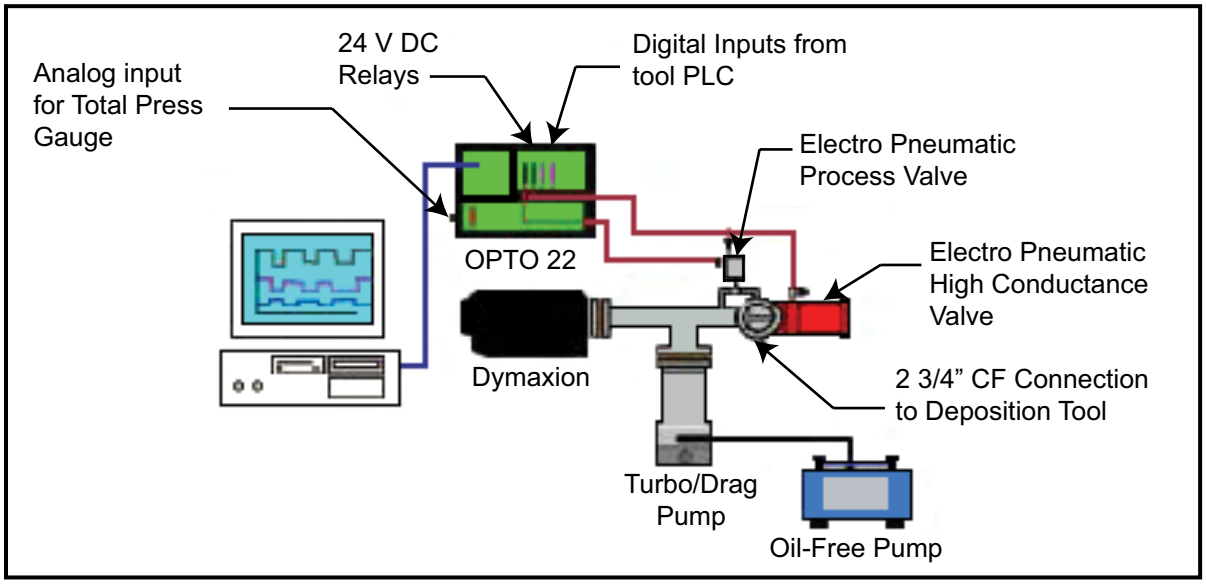

Figure 3. How to integrate the Dycor RGA into a deposition tool. An RGA can serve both as a diagnostic and process monitoring device. It provides the advantage of monitoring production without interfering with the deposition process.

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