AMETEK®
PROCESS INSTRUMENTS

APPLICATION NOTE

OPTIMIZING SOLAR PANEL PRODUCTION WITH THE DYCOR LC-D RESIDUAL GAS ANALYZER

Solar panels produced via the thin-film deposition process are efficient and small. The thin-film deposition technique allows 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 technique can be physical vapor deposition (PVD), chemical vapor deposition (CVD), or plasma-enhanced CVD (PECVD). Regardless of the technique, the Dycor LC-D residual gas analyzer (RGA) can be used to provide process information over a wide range of pressures, typically from 5 Torr to 10e-5 Torr. This information is crucial for both manufacturing quality and quantity.

In its simplest form, the Dycor LC-D is used to monitor the thin-film line during pump down. With its high sensitivity and excellent long-term stability, the RGA is the perfect early warning system for deposition line problems. At the completion of the deposition run, the deposition tool undergoes a preventive maintenance cleaning process to remove deposits from the walls of the chamber. Following this, offline post-preventive maintenance PM requalification takes place as the tool is pumped down to process operating conditions (Figure 1).

An 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 LC-D can be used to record these pump-downs in the form of partial pressure versus time curves. Developing pump-down 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, humidity, target changes, cryopump regenerations, chamber hardware replacement, real leaks, and virtual leaks all contribute to the variability in pump-down rates.

By using statistical process control methodology to help characterize these variables, pump-down 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 result is more time spent making product rather than recovering from preventive maintenance servicing.

The Dycor LC-D is a non-invasive process monitor that can be used to characterize the deposition process by plotting the presence or absence of a gas species with respect to time. A baseline 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).

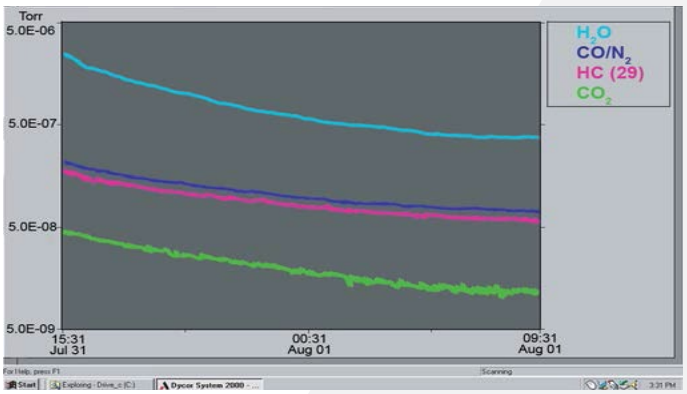

Figure 1. The Dycor Quadrupole RGA can be used to record pump- downs in the form of partial pressure versus time curves. Pump- down curves can be used as a reliable early warning system for a variety of vacuum problems

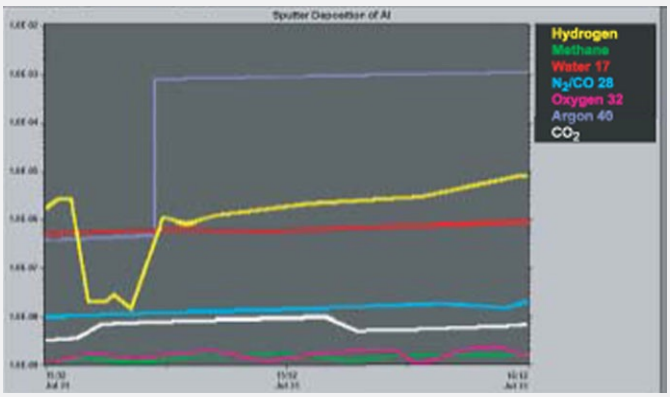

Figure 2. Process monitoring run of sputtered deposition

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.

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 are available to allow the Dycor LC-D to assume control of the process, initiating process state changes as needed.

System 2000 software 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 baseline. Conclusions drawn from these comparisons can directly reflect the product quality and yield. 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.

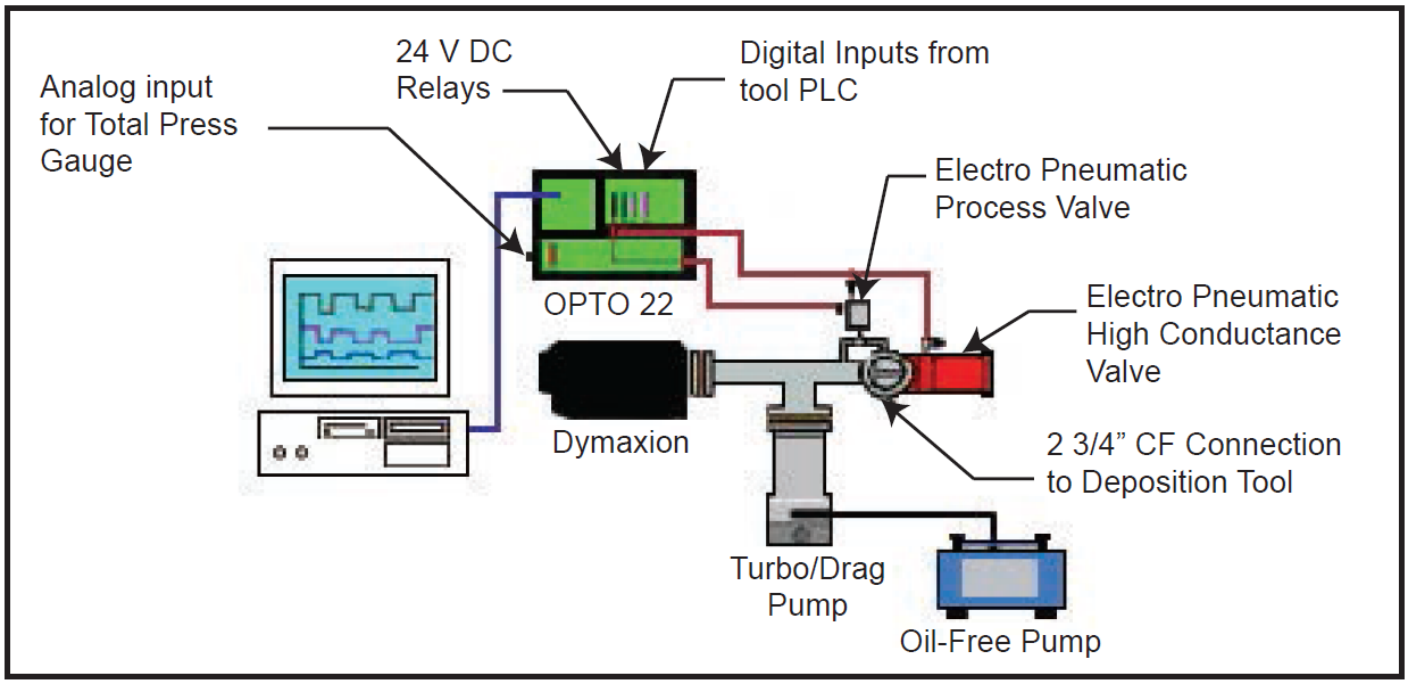

Figure 3. How to integrate the Dycor RGA into a deposition tool. An RGA can serve both as a diagnostic and process monitoring device. It provides the advantage of monitoring production without interfering with the deposition process

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