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Technology for Productivity

Application Note

HPQ2-S For Process Monitoring On Large Area Coating Tools

BACKGROUND

A major manufacturer of large area glass coating equipment required the ability to control film quality following a reactive sputtering process. High quality films are only produced when the conditions before, during and after the sputtering process are fully optimised. Four key factors influence the film quality:

1. **Process Gas Levels/Concentrations**
   Typically, process pressures are 5 x 10^{-3} mbar (3.75 x 10^{-3} Torr). System pressures must be strictly controlled during process as pressure instabilities impact individual film qualities and consequently the properties of the entire film stack.
2. **Baseline conditions prior to processing**
   Baseline pressures prior to processing must be 1 x 10^{-5} mbar (7.5 x 10^{-6} Torr) or less. This ensures that the contaminant level in the process chamber is low enough to produce quality films.
3. **Contamination from the substrate during processing**
   There is some possibility of film contamination during processing arising from the presence of substrate surface or bulk contaminants.
4. **Vacuum condition following preventative maintenance**
   Following scheduled maintenance to the tool, the pumpdown and baseline vacuum must be monitored to ensure there are no leaks or contaminants present.

SOLUTION

This application required a system capable of monitoring chamber conditions to control the above factors at chamber pressures ranging from 10^{-5} mbar to 5 x10^{-3} mbar. The HPQ2-S (Figure 1) was identified as the optimal solution. The HPQ2-S determines the data required to control the listed factors and does so without the need for differential pumping, resulting in a compact, cost effective and easily integrated monitoring system.

An HPQ2-S system was installed as an automated sensor performing the following operations:

1. Monitor the partial pressures of selected gases against time during pumpdown and generate an alarm if the checkpoint/limits are not reached.
2. Monitor the baseline pressure prior to processing or when the system is idle and generate an alarm if the background levels go beyond specification. This operation requires that a baseline sensitivity calibration be performed at regular intervals.
3. Monitor the chamber during the process with selected data transferred to the control system. Generate an alarm when values deviate from the set limits. As with the baseline monitoring, this requires that a process sensitivity calibration be performed at regular intervals.
4. Monitor the post-processing baseline pressure and check for chamber contamination. Generate an alarm if the levels of contaminants go beyond the specification.

Figure 1 - HPQ-2S

INTEGRATION

Since the application of this solution to multiple large area coating tools in the manufacturing line was required, system costs could be reduced by deploying client-server architecture. Figure 2 shows a schematic representing eight such tools, each fitted with an RGA. The distance between the RGA and the Process Eye™ server can be up to 200 metres. To enable control over long distances a fibre optic interface was supplied at the customer site and tested for groups of up to four RGAs and the server. Each of the servers was connected to the Client (Operator) PC over the FAB network.

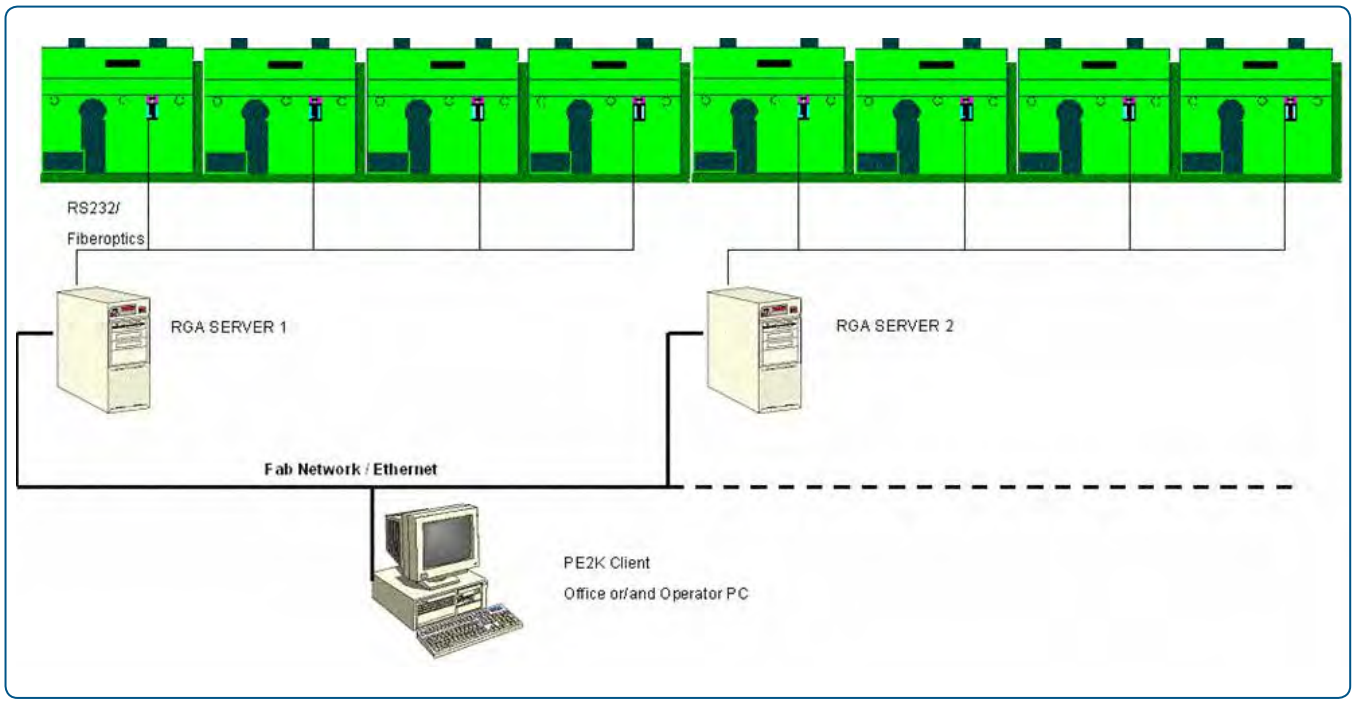

Figure 2 - RGA Client-Server Integration

Other integration requirements that were met included:

1. **Integration to tool control**
   Integration to existing tool control software was performed using the Visual Basic recipe structure to create XML interfaces.

2. **Partial pressure control (Ar/O_2) for reactive sputtering**
   Monitoring the Ar/O_2 ratio accurately in these tools requires a fast scan time. This was achieved using peak jump mode where the scan jumps between masses 32 (O_2) and 40 (Ar) rather than scanning all the masses in between. The values are fed back to the tool control system via a 0-10VDC Analog output.

3. **Ease of access and data presentation**
   As the system was to be used on a production tool it was preferable that the data be presented in a display easily interpreted by a non-specialist operator. An HTML-based user interface was created which was linked to Process Eye Professional software and which displayed only the key information. Figure 3 shows the Coating Profiler Screen which displays the total pressure, nitrogen and water partial pressures, and the Argon/Oxygen ratio. This example shows only modules 1-4, but it is possible to display all of the modules in batches of four. The modules shown are within the acceptable limits and

INTEGRATION (CONT'D)

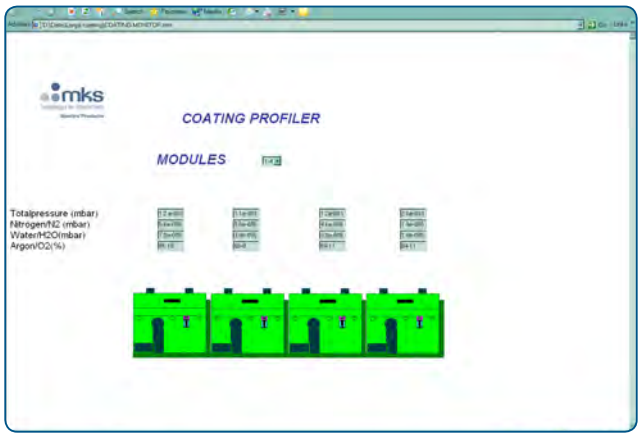

Figure 3 - HTML User Interface Display

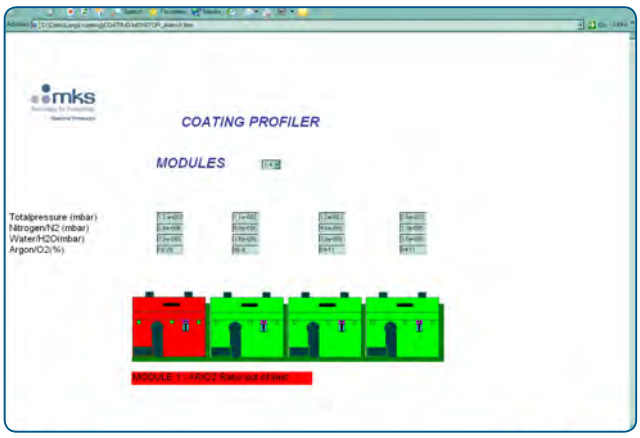

Figure 4 - HTML User Interface (Alarm)

Figure 4 shows the same four modules when one of the limits is breached. As the Argon/Oxygen ratio is outside of the acceptable limits, the module appears red to warn the operator that there is a problem. A comment box also appears to inform the operator of the reason(s) for the alarm.

Trend windows in Process Eye can provide a more detailed data analysis of the partial pressures of selected gases at each stage of the process with the addition of the capability to display data from other sensors (e.g., gauges, thermocouples, etc.). This information can be used to locate and understand when problems arise. An example trend window is shown in Figure 5.

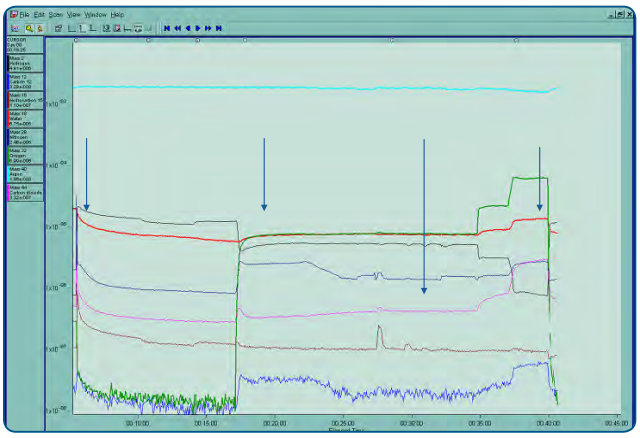

Figure 5 - Process Eye™ Trend Display

Figure 5 shows how the trend displays can provide information on each stage of the process clearly identifying problems as they arise. In this example the difference in gas composition for a reactive and non-reactive process are clearly displayed. Trend displays can also be used to detect when a chamber is contaminated from the substrate.

CONCLUSION

Following the installation of the HPQ2-S and its integration with the Tool Control System, the customer observed significant benefits in several key areas:

- An improved ability to detect contamination (including contamination from substrate) prior to processing.
- Improved process reproducibility and film quality due to reduced numbers of in-process deviations.
- An enhanced capability and speed of problem resolution for vacuum troubleshooting during pumpdown and following preventative maintenance.

Implementation of the HPQ2-S with its powerful Process Eye software in this coating line thus enabled process optimisation and vastly improved diagnostic monitoring of the vacuum quality to detect contamination and process variability.

For further information, call your local MKS Sales Engineer or contact the MKS Applications Engineering Group at 800-227-8766.

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