INFICON

APPLICATION NOTE

TRANSFER CHAMBER MONITORING

200mm and 300mm PVD Cluster Tools

Integrated Process Metrology (IPM) utilizes *in situ* sensors to provide process data in real time. This data can be used to fingerprint process conditions, identify process faults, pinpoint problems, and tune recipes for greater yield.

Transfer chamber monitoring is one of the easiest and least expensive ways to implement IPM, using a Residual Gas Analyzer (RGA) for monitoring process chemistries and contamination. This IPM employs an open-source RGA mounted on the transfer chamber which is connected to the FabGuard® Analysis System. Sensor operation is integrated with production tool operation (communicating with FabGuard via SECS or HSMS), allowing a single RGA to monitor the transfer chamber for hydrocarbon contamination and air leaks, and each individual process chamber for any pump down.

SYSTEM CONFIGURATION

The RGA Recipe is set up to acquire the appropriate tool IDs so that FabGuard can determine which chambers are opening and closing. Some of these IDs include:

- Process chamber slit valves
- Transfer chamber pressure gauges
- Cryopump stage temperatures
- Slit valves to chamber A and cool B

The recipe is then set up with signal bins much like the ones used on a process chamber. These signal bins include selections such as:

- Normalized partial pressures of common gases and contaminants for the transfer as well as each process chamber and chambers A/B
- Transfer chamber cryopump health and pumping efficiency
- RGA diagnostics such as signal-to-noise levels and sensitivity

Typical Species Monitored:

✓ Argon	✓ Methane
✓ Oxygen/Air	✓ Ammonia
✓ Water	✓ Total Hydrocarbons

Signal bins are normalized so that they remain consistent over time. By implementing a partial pressure contribution to the chamber, signal bins are shown as a percentage of the total and therefore are independent of sensor variance over time.

To create chamber specific signal bins, tool data for slit valve position and logical expressions are combined to build a signal that only exists when all other process chambers are isolated and one is open. This way there is no question as to where the signals originated.

APPLICATION EXAMPLES

Leak and Cross Contamination Detection

The most common contamination source in PVD cluster tools is an air leak. An air leak in the transfer chamber will cause the freshly exposed surface of wafers arriving from the sputter clean to be introduced to water residuals that can affect film properties. This same air leak can then contaminate the process chambers, which are not only sensitive to water, but may also be susceptible to oxidation of metal depositions. The high sensitivity of the RGA detects air leaks originating in the process chamber when slit valves are open. Figure 1 shows an example of an RGA on a transfer chamber detecting an air leak in a PVD process chamber with FabGuard.

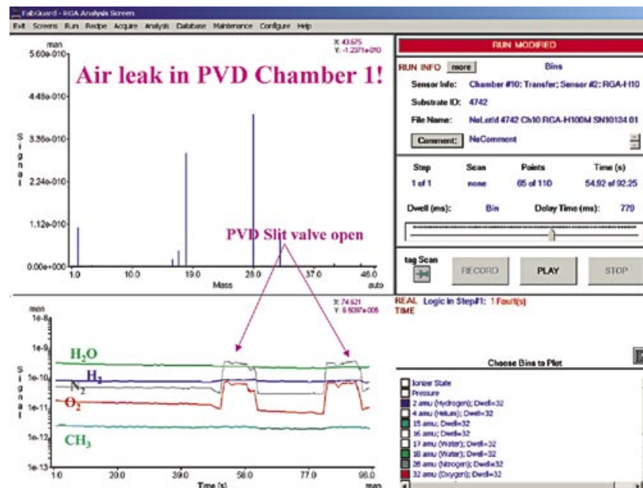

Figure 1 - Leak discovered in process chamber

A process chamber can contaminate a transfer chamber, since all chambers are interconnected. In a cluster tool, process gasses themselves can be considered contamination if they are transported to other process chambers. One such case, on a cluster tool with TiN CVD and PVD chambers, is shown in Figure 2. A single RGA with FabGuard discovered and helped to resolve multiple problems. The first problem was CVD process gasses back-streaming into the transfer chamber and then on to other process chambers. The second problem was created when large amounts of hydrogen saturated the transfer chamber cryopump causing it to prematurely lose pumping efficiency. Both problems were resolved by increasing the pump down time in the CVD chamber before wafer transport.

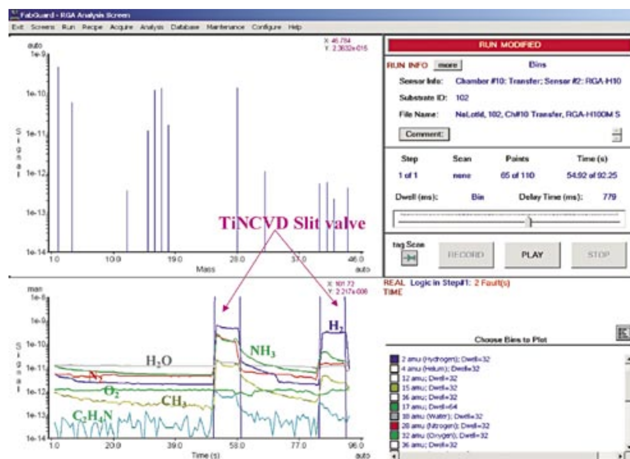

Figure 2 - H2 and Hydrocarbon Contamination

Cryopump Performance

A cryopump is an essential component of a transfer chamber. An IPM for the transfer chamber can be used to monitor the partial pressures of hydrogen and helium. By combining this data with tool data of the cryopump's first and second stage temperatures, the software can track the pump degradation to help operators choose optimum times for regenerations. This helps to streamline preventive maintenance schedules and avoid unplanned downtime due to component failure.

Preventive Maintenance Recovery

Preventive maintenance is a necessary part of manufacturing that leads to nonproductive tool time during component replacement and cleaning, as well as chamber pump down and recovery. With a specific preventive maintenance recovery recipe, an IPM for the transfer chamber can monitor partial pressures and ratios of gas components, providing instant indication of potential problems before the tool takes the time to try and reach baseline pressure goals. This saves valuable operation time. During a normal pump down, the IPM can be used to indicate and optimize when the chamber is ready for operation.

IPM for Transfer Chamber Monitoring Capabilities At A Glance

- ✓ Fully automated operation
- ✓ Air leak detection
- ✓ Cross contamination detection
- ✓ Cryopump performance
- ✓ Faster PM recovery
- ✓ Flex-logic signal conditioning
- ✓ Multi-functional data analysis
  - Real time analysis
  - SPC analysis
- ✓ SQL searchable database
- ✓ Hardware: H100M and IPM Controller with FabGuard

Applicable Tool Configurations

- ✓ AMAT 200mm Endura
- ✓ AMAT 300mm Endura
- ✓ Novellus 200mm INOVA
- ✓ Novellus 300mm INOVA
- ✓ ULVAC 200mm Ceraus Zx-1000
- ✓ ULVAC 300mm Entron
- ✓ Unaxis 300mm Clusterline
- ✓ Other possible tools utilizing low pressure Transfer Chambers

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