INFICON

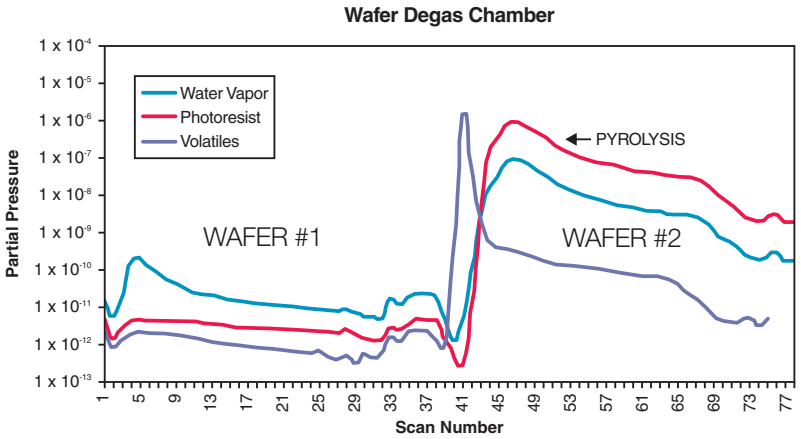
# Preclude™

## Photoresist Detector

Reliably Protects PVD Cluster Tools
from Photoresist Contamination

# *In Situ* Photoresist Detection to Reduce Downtime

Today's physical vapor deposition (PVD) cluster tools demand the utmost in cleanliness. Even contamination in the range of a few parts per million (ppm) can cause problems. So when a wafer with residual photoresist is heated under vacuum in the degas chamber, causing the photoresist to vaporize and spread throughout the tool, the result can be a disaster. Your high-throughput PVD tool is brought to a halt and can be offline for days. That's extremely costly in terms of lost production and man-hours for clean-up.




Two wafers run through degas cycles. The first (scans 4 through 29) shows a typical wafer where small amounts of water vapor outgas. The second wafer is contaminated and demonstrates the mechanisms of photoresist outgassing. An initial burst of low-vapor-pressure gases is released as the wafer temperature ramps up. At sufficiently high temperatures, photoresist compounds experience pyrolysis, which can result in large portions of a PVD cluster tool becoming contaminated.

INFICON Preclude™ Photoresist Detector prevents this expensive downtime by continuously monitoring the degas chambers for the signatures of photoresist compounds. Once Preclude detects photoresist, it triggers an alarm and/or provides an output that can be used to automatically stop the degas cycle, mitigating the contamination of the tool.

## STOP SMALL PROBLEMS FROM BECOMING BIG ONES

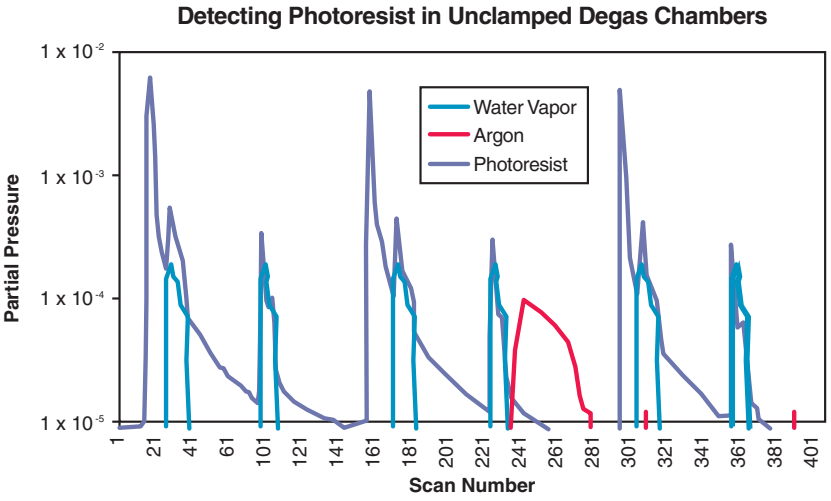
Ideally, the ashing and stripping steps that precede degassing should leave the wafers completely free of photoresist. But that doesn't always happen. Photoresist removal can be incomplete or inadvertently missed altogether. Even trace levels of photoresist that are too small to contaminate the tool can cause problems with the deposition processes that follow wafer degassing, reducing your yields.

Preclude monitors every wafer degas cycle for photoresist contamination. Once installed, it needs no operator involvement. In fact, unless it detects a contamination problem, you'll hardly know it's there.

## FEATURES AT A GLANCE

- Detects photoresist in PVD tool degas chambers, mitigating contamination that can cause costly downtime and extensive clean-up
- Sensitive enough to detect trace photoresist contamination that, while not harmful to the tool, can cause problems with later deposition processes
- Patent-pending technology prevents false alarms
- Runs continuously and automatically without user intervention
- Can share a PC with Transpector® gas analyzers

To ensure reliability, we tested the Preclude system in the real world. It continuously monitored production PVD tools for well over a year, providing trouble-free contamination detection. A major source of this reliability is the INFICON Transpector® Residual Gas Analyzer (RGA) that's at the heart of every Preclude system. Because of its proven record of unrivaled durability, the Transpector is found on more tools than any other RGA. When the PVD tool is down for maintenance,




Detecting photoresist is complicated by large pressure excursions typical of systems employing unclamped degas processes. The degas chamber is often not isolated from events taking place in the buffer chamber. As wafers are cycled in and out of the PVD cluster tool, large spikes of water vapor are observed as loadlocks are opened to the buffer chamber. Argon bursts associated with cooldown chambers being vented into the buffer chamber account for more severe effects. Outgassing from a wafer contaminated with photoresist and subject to degas heat is seen at scan number 221. A photoresist detection system must be able to distinguish harmless tool behavior from true photoresist events.

the Preclude Photoresist Detector can be operated as a full-featured RGA, complete with high-sensitivity helium leak detection.

## ADVANCED TECHNOLOGY ELIMINATES FALSE ALARMS

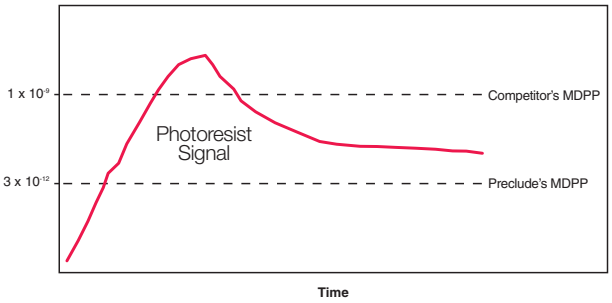
Preclude is designed to prevent PVD tool downtime and increase wafer yields. Any false alarms would have the opposite effect, so we were careful to ensure that Preclude's extreme sensitivity didn't come at the expense of reliability.

PVD tool degas chambers are typically mounted on vacuum buffer chambers, which are a hub for load-locks, process chambers, passthroughs and cool-down stations. All this activity creates numerous pressure transients that could easily trigger false alarms in a less sophisticated photoresist detector.

To ensure that doesn't happen, INFICON worked in cooperation with several semiconductor fabs to develop patent-pending technology that simultaneously looks at many factors during a suspected contamination event. This intelligent system gives Preclude its combination of unsurpassed sensitivity and reliability.

## HOW PRECLUDE PHOTORESIST DETECTOR WORKS

Preclude uses quadrupole mass spectrometer technology to continuously monitor the degas chamber. During the degas cycle, the wafer temperature is typically ramped up under vacuum to 250ºC. When no photoresist is present, only small amounts of water vapor will outgas from the wafer surface. But when there is photoresist contamination, the water vapor will be accompanied by a rapid rise in the volatile compounds that were used to suspend the photoresist in a liquid state when it was applied to the wafer. These volatile compounds, while generally not harmful, are a precursor of the problems to follow. Next come the smoke-like byproducts of the hardened photoresist as it breaks down or burns. These can spread throughout the tool, leaving residues on chamber surfaces. Preclude detects and analyzes all these events to provide reliable photoresist detection while eliminating false alarms.




## DETECTION TIME FOR PRECLUDE VS. COMPETITION

Because the INFICON Preclude detects photoresist at lower levels than other instruments, photoresist can be detected earlier. (Data based on published specifications. Preclude at 32 ms dwell and EM off.)

## SPECIFICATIONS

| | |
|---|---|
| **Operation** | Fully automatic once photoresist recipe is initialized |
| **Maximum Continuous Operating Pressure**[1] | < 1 mTorr |
| **Maximum Permissible Pressure Bursts**[2] | 20 mTorr at the Preclude sensor |
| **Emission Interlock**[3] | Pirani thermoconductivity gauge |
| **Mass Position Stability**[4] | < 0.1 AMU over 24 hours (after 30-minute warm-up) |
| **Peak Amplitude Stability**[4] | < 2% over 24 hours (after 30-minute warm-up) |
| **Achievable Instrument Reproducibility**[5] | < 2% deviation |
| **Temperature Stability**[4] | < 1% of peak height per °C (with EM off) |
| **Detection Time for One Photoresist Channel**[6] | 28 ms |
| **Detection Time for Six Photoresist Channels**[7] | < 1 second (typical application) |
| **Activation Time** (Time to Alarm) | Programmable timer after detection time: 0-25 seconds |
| **Recommended Preventative Maintenance** | Ion source replacement after 4,000 hours (typical application) |
| **Minimum Detectable Partial Pressure (MDPP)**[8] | $3 \times 10^{-12}$ Torr ($4 \times 10^{-12}$ mbar) FC operation for photoresist detection |
| **Minimum Detectable Helium Partial Pressure**[9] | $3 \times 10^{-14}$ Torr ($4 \times 10^{-14}$ mbar) EM operation for leak detection |
| **Electronics Dimensions** | 4.87" (12.4 cm) x 5.62" (14.3 cm) x 7.75" (19.7 cm) |
| **Overall Dimensions** (without interlocks) | 6.65" (16.9 cm) |
| **Detector Type** | Microchannel Plate EM/FC |
| **Software** | TWare32 |
| **Photoresist Set-up** | Programmable masses, recipe driven |
| **Alarm Output** | Boolean logic for AND/OR of photoresist channels |
| **Hardware Output** | Relay output, 24 V at 0.5 amps |
| **Connection to Tool** | Prewired cable on Preclude end with terminating wires on tool end, 30' (9 meter) length |

CE Compliant

1 Recommended pressure range $< 5 \times 10^{-5}$ Torr ($6.7 \times 10^{-5}$ mbar) for optimum linearity.

2 Maximum permissible pressure bursts must be less than 30 seconds.

3 When ordered with optional Pirani interlock.

4 Stability of a FC signal at $1 \times 10^{-5}$ Torr of nitrogen, constant STP.

5 Factory FC reproducibility based on sensitivity after calibration at $1 \times 10^{-5}$ Torr of nitrogen.

6 Detection time for one channel with 8-ms dwell time, peak lock off, baseline subtraction off and after pressure bursts.

7 Detection time for six channels with 32-ms dwell times, peak lock on, baseline subtraction on and after pressure bursts.

8 Minimum detectable partial pressure (MDPP) is calculated as the standard deviation of the noise (minimum detectable signal) divided by the sensitivity of the sensor measured at a 32-ms dwell time.

9 Minimum detectable partial pressure (MDPP) for helium is calculated as the standard deviation of the noise (minimum detectable signal) divided by the sensitivity of the sensor measured at a 4-second dwell time with a helium ionization factor.

INFICON Instruments for Intelligent Control®

www.inficon.com reachus@inficon.com