



# Mass Spectrometry Solutions

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## TOOLweb<sup>®</sup> RGA

### AUTOMATED PROCESS & CHAMBER ENVIRONMENT MONITORING

As semiconductor device geometries shrink and wafer sizes increase, there is a clear recognition of the value that tool and process data can bring to maximizing yield and optimizing tool performance. Of the various sensors routinely used to monitor process and vacuum chamber conditions, Residual Gas Analyzers (RGAs) are proven to deliver many benefits:

- Detection of wafer borne contaminants
- Monitoring of process gas composition and purity
- Identification of chamber leaks
- Monitoring of chamber pump performance
- Highlighting of chamber issues to speed up PM recovery
- Chamber-to-chamber comparisons

TOOLweb<sup>®</sup> RGA is an automated platform for the control and monitoring of process-specific sensors on various semiconductor tools. Comprised of sensor hardware, a tool connectivity module, and software for real-time control and web-based data review, TOOLweb RGA monitors the tool chamber environment both during and between periods of wafer processing and after a pumpdown.

Through continuous communication with the tool, TOOLweb RGA is able to link process gas data with wafer logistics information and alarm or warn the tool in the event of a process excursion. Additionally, it can access other tool data (VIDs) using it for fault detection and sensor calibration, and incorporating it into TOOLweb RGA web-based reports.

The TOOLweb RGA platform can function either as a stand-alone “tool level” product or as a component part of a wider scale FDC system, exporting sensor data and calculated indices for incorporation into factory data systems. The data captured throughout different tool phases informs process and equipment engineers of degradation in environment conditions. TOOLweb RGA can produce long-term data summary reports that illustrate tool and chamber performance over long periods of time. TOOLweb RGA is a scalable, real-time, web-enabled hardware and software suite of solutions for a variety of tools, processes, and product types. Among its many powerful capabilities is access to advanced “multivariate” fault detection capabilities for off-line and on-line data analysis.



## TOOLweb® Residual Gas Analyzer (RGA) Sensors and Atmospheric Mass Spectrometry (MS) Systems

TOOLweb RGA sensors are specially configured to monitor different tool and process environments. They can highlight a variety of process and tool issues to ensure that throughput, yield, and tool uptime is maximized.

### 300mm Resist-Torr® XD Photoresist Detection Monitor

Specifically designed for degas chambers on industry-leading 300mm PVD cluster tools. This RGA incorporates V-lens™ technology to provide a new level of sensitivity (<15ppb), with advanced algorithms (PR Index) enable rapid identification and alarm for wafer borne contaminants including photoresist.



### Vision 2000-C™ XD and Vision 2000-E™ XD ALD, CVD, and Etch Process Monitors

These systems allow seamless monitoring of the complete ALD, CVD or Etch process cycle, from base vacuum to process pressures of up to 700 Torr. The use of V-lens technology in both systems provides higher sensitivity (<15ppb) allowing for faster identification of potential manufacturing issues.



### Vision 2000-P™ XD PVD Process Monitor

Vision 2000-P™ XD provides simple and effective PVD process monitoring of contamination levels within semiconductor and thin film PVD process tools. With V-lens technology, process engineers can identify and prevent issues faster and easier than ever before while maximizing manufacturing yield.



### HPQ3 and HPQ3S™ High Pressure Compact Quadrupole Monitors

These monitors operate far beyond the 1e-4 mbar total pressure limit of other residual gas analyzers without the need for differential pumping. They offer a variety of software control options to match the requirements of any application.



### Vision 2000-B™ Transfer and Buffer Chamber Monitor

This monitor tracks gases in the transfer chamber environment with correlation to process chamber slit valve positions so that the existence of leaks and the potential for process chamber cross-contamination can be highlighted and rectified.



### Cirrus™ 3 and Cirrus™ 3-XD Atmospheric Pressure Mass Spectrometers

These systems allow detection and profiling of gases at elevated pressures in selected applications. They are ideal for detection of gases and contaminants in the low ppm and low ppb ranges.



## Real-Time Applications

The TOOLweb RGA real-time applications operate through the Process Eye Professional™ sensor control platform to ensure all installed sensors deliver stable, high quality data at all times. Included in the real-time applications is a fault detection and classification capability with multiple possible actions to be taken in the event of a process excursion.

A web-based application is provided to configure TOOLweb RGA and to make adjustments to alarm settings as well as the selection and configuration of tool VIDs for tracking. Real-time application features:

- Fully automated acquisition of RGA and independent sensor data throughout different tool chamber states (process, baseline, and pumpdown)
- Real-time displays of acquired data, alarm status, and sensor status
- Configurable for a range of different 200mm and 300mm process tools and offering a flexible approach to tool integration
- Performs self calibration at both process and base vacuum pressures
- Offers real-time fault detection with the ability to use statistical limits derived from univariate modeling
- Automatic selection of alarms on the basis of wafer type (lot) and process recipe
- E-mail notification of alarms and warnings to defined recipient groups
- Alarm conditions can be sent to the tool controller and may be used to stop the tool or hold a contaminated wafer while others complete processing



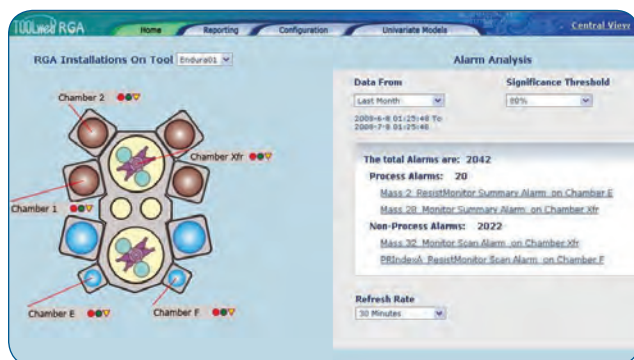
## Web-Based Applications

The tool dashboard provides an instant view of the status of the tool, the health of each sensor, and the latest alert status for the chambers. It also provides an automated Pareto analysis of the warnings and alarms from the sensors being monitored on the tool. Instead of running a report for each chamber or process, a web page link makes it possible for engineers to see at a glance any recurring problems and to drill down further into the data. From the tool dashboard it is possible to link to all of the TOOLweb RGA web pages.

The web-applications included with the TOOLweb RGA product suite offer data reporting and database search capabilities and are accessible from any location on a network (or over the internet) using a web browser with no requirement for software installation or downloading. Web-applications typically run on the same control PC as the real-time applications, however, the database and data files may be located on a separate server on the same network.

### Data Summary Reports

- Available for different tools and chambers over defined periods of time with specific reports for process, base line and pumpdown conditions.
- Click on outlier wafers within a report to identify numeric data values, Lot ID, wafer ID, and process recipe. Drill down to see “raw” bar chart and trend data collected during wafer processing.
- Reports can be filtered to show only a subset of wafers that were processed by specified process recipe(s), belonging to certain lots etc.



TOOLweb RGA dashboard showing tool sensor health status and real-time automated Pareto analysis of tool and process problems

### Favorite Reports

- Similar to standard data summary reports but with pre-defined tool, chamber, and time period. Allows chamber-to-chamber comparisons to be made within the same report and includes wafer identification and drill-down to view “raw” data.

### Wafer Search

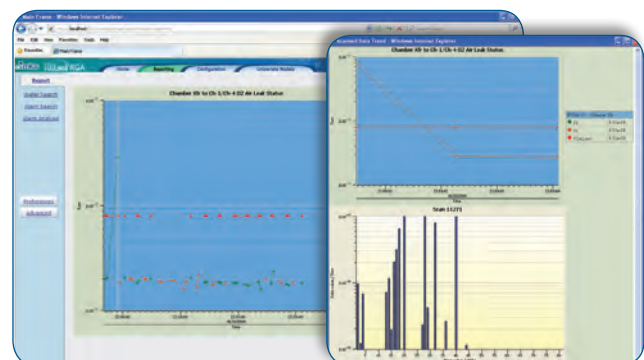
- Operator can search for a specific wafer or lot; and drill down to view “raw” RGA, sensor, and VID data.

### Summary Alarm Search

- Automatically lists alarm and warning events occurring on a particular tool and chamber over a specific period of time and provides a summary of the root cause. Includes drill down capability to view “raw” RGA and VID data.

### Complex FDC Modeling

- By using data captured during the normal processing of wafers, TOOLweb RGA builds statistical models using both “raw” and “summary” RGA, sensor, and VID data.
- These models can either be created by the internal tools of TOOLweb RGA or the data can be exported in real-time to an external MKS or 3rd party data processing package for fault determination.
- The returned real-time result of the FDC analysis can be automatically re-imported into TOOLweb RGA for alarm actions and for use in standard reporting methods.



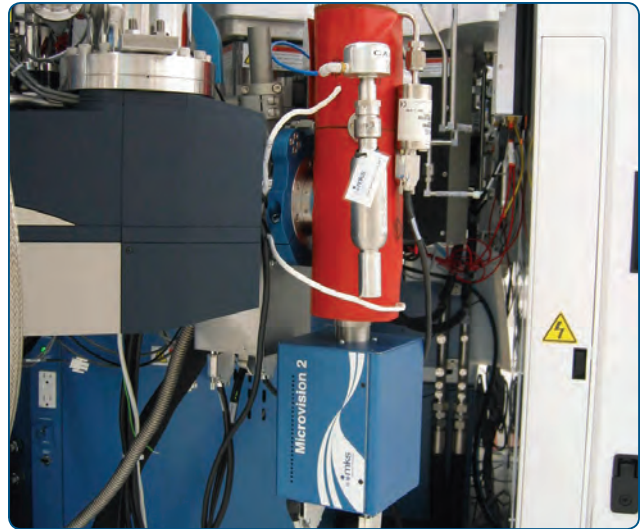
TOOLweb RGA standard report showing drill down to view raw sensor data



## Flexible Sensor Integration

TOOLweb RGA maintains continual communication with the tool to access information required for its operation. Wafer logistics information, tool VIDs, and the communication of "events" (e.g., wafer process start) are all required to drive the RGA state engine logic and ensure that there is correlation between sensor data and wafer specific information in the database. Additionally, TOOLweb RGA can send information in real-time to the tool, Fab host or an APC platform. Such information might include alarms, calculated indices, events, or sensor data.

TOOLweb RGA can be configured in a number of different ways. See the application note, "TOOLweb RGA: Connectivity and Scalability" for more details.



TOOLweb RGA 300mm Resist-Torr installed on a degas chamber



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