

# OMA-300 SEMICONDUCTOR EDITION

State-of-the-art monitoring for an industry that defines state-of-the-art.

Photograph of processor by Rodrigo Semra, 2005.



THE **OMA-300** IS OUR FLAGSHIP ANALYZER—the technology that built AAI. At its core lies the nova-II, a UV-VIS-SW-NIR diode array spectrometer.

The **SEMICONDUCTOR EDITION (SE)** is a configuration of the OMA-300 designed for online monitoring at several yield-critical junctures in wafer production. The various aqueous solutions used for cleaning and etching silicon wafers are precise mixtures; it follows that tight control over their chemical ratios provides a means of closely regulating parameters like etch speed and health/efficacy of wash solutions.

The **OMA-300 SE** is a true multi-component analyzer. The spectrometer houses 1,024 photodiodes for full-spectrum detection, allowing great flexibility and selectivity for component absorbance ranges. The Eclipse software provides a simple and clean user interface, but under the hood it houses the proprietary algorithms that govern multi-component monitoring with unrivaled accuracy.

This system is engineered to continuously monitor the chemical composition of RCA cleaning solutions, CMP slurries, wet etchants, and/or wastewater, measuring up to four stream components without any cross-interference. The **OMA-300 SE** is also easily configured for sensitive feedback control.

**Semiconductor fabs are among the most strictly moderated manufacturing environments found in any industry. Let AAI technology safeguard your process with the same diligence.**

## FEATURE OVERVIEW

- nova-II DIODE ARRAY SPECTROMETER  
dispersive UV-VIS-SW-NIR; 1,024 photodiodes for full spectrum analysis
- RUGGED SOLID STATE CONSTRUCTION  
no moving parts, low-maintenance performance
- MULTI-COMPONENT MONITORING  
no cross-interference between analytes
- FAST RESPONSE ( $T_{90} = 2s$ )
- CONFIGURABLE FEEDBACK CONTROL  
automated valve operation (optional)
- AUTOMATED ZERO CYCLE
- FIBER OPTIC CONNECTIVITY  
electronics safe from solution fumes
- CLEANROOM-SAFE  
flow cell wetted materials: Teflon or PEEK body; sapphire windows
- LONG-LIFETIME LIGHT SOURCE  
xenon or tungsten (application-specific)
- 4-20mA OUTPUTS; ETHERNET/SERIAL MODBUS
- SIMPLE GRAPHICAL INTERFACE  
easy to use; video tutorials provided

## APPLICATIONS

- CMP SLURRY HEALTH  
 $H_2O_2$  % weight;  $NH_4OH$  % weight
- RCA CLEAN  
SC-1 (ratio of  $NH_3$  to  $H_2O_2$  to  $H_2O$ );  
SC-2 (ratio of  $HCl$  to  $H_2O_2$  to  $H_2O$ )
- SPM (SULFURIC PEROXIDE MIXTURE)  
ratio of  $H_2SO_4$  to  $H_2O_2$  to  $H_2O$
- ETCHING BATH COMPOSITION  
monitor HF concentration for ultra-precise control over etch rate
- METAL IONS  
Cu, Co, Ni, Pb, and others in electroplating and wastewater for increased social responsibility

# OMA-300 SEMICONDUCTOR EDITION

## Some Background

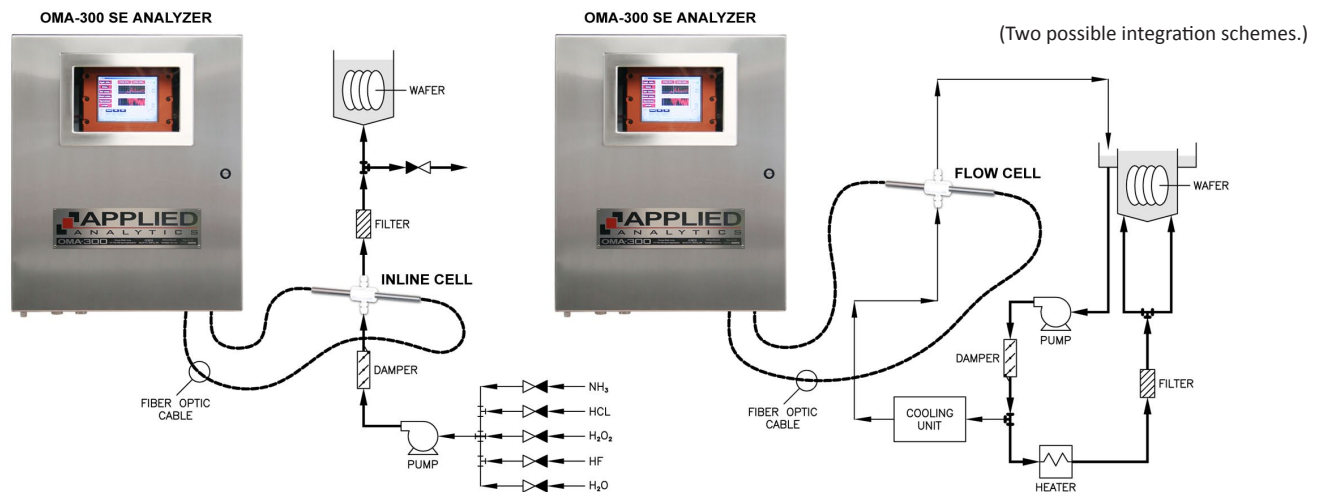
In semiconductor manufacturing, yield improvement is a rigorous science. Fabrication plants, or fabs, are intensely regulated: cleanrooms are built to maintain minimal concentrations of airborne particles, often precisely controlled for temperature, positive pressure, and humidity. When so much care is taken to prevent wafer contamination and avoid scrap, more attention should be paid to the integrity of the chemicals that wafers interact with throughout production. For some of the sensitive applications below, an error in dilution ratio as small as 1% can significantly degrade yield.

## AREAS FOR ANALYSIS & AAI TECHNOLOGY

### • CMP Slurry

Chemical Mechanical Planarization (CMP) is used in fabs to polish the surface of silicon wafers and remove imperfections as layers of circuitry are deposited. Small errors in the composition of CMP slurries can contribute to defectivity, raise cost-of-ownership, and cause micro-scratches or corrosion. A major aspect of maintaining CMP slurry health is keeping the concentration of the oxidizer (often  $H_2O_2$ ) constant as per specification in the slurry/oxidizer blend. As chipmakers continue to squeeze in more transistors, more layers of circuitry must be smoothed by CMP—leaving more to be gained from slurry health analysis.

The **OMA-300 SE** provides real-time monitoring of  $H_2O_2$  concentration with 0.05 wt% accuracy for a 0-5 wt% range. Even for CMP slurry blends from the same batch/manufacturer, quality can vary widely in the fab; slurry delivery method, filtration type, and replenishment cycle are all significant sources of error. Integrated feedback control (via 4-20mA signals) allows the analyzer to operate valves and spiking pumps during distribution. This automates tight control over oxidizer concentrations, saving yield and the cost of CMP consumables.



### • RCA Clean (SC-1 & SC-2)

“Standard Clean” 1 and 2 are the most common cleaning solutions used to remove undesired compounds from the silicon surface. SC-1, which removes organic contaminants, contains  $NH_3$  (30%),  $H_2O_2$  (30%), and ultra-pure DI water in an exact 1:1:5 ratio. SC-2, meant for metallic contaminants, is made with a 1:1:6 ratio of HCl (37%),  $H_2O_2$  (30%), and DI water. Assuming these precise ratios to be stable can be a costly misjudgment, especially considering the chemical changes occurring through the cleaning process and evaporation from an 80 °C bath. When cleaning solutions drift from recipe specification, the process can suffer from non-uniform wafer cleaning and increased wafer rework—risking yield and lengthening cycle time.

With multi-component analysis in the form of the **OMA-300 SE**, these critical ratios can be continuously validated without any cross-interference. For an SC-1 bath, the graphical interface displays dynamic concentrations of analytes  $NH_3$ ,  $H_2O_2$ , and  $H_2O$ , as well as their exact ratio. From a production perspective, a satisfactory cleaning process maximizes wafer yield yet also minimizes chemical cost and downtime. The unrelenting accuracy of the **OMA-300 SE** lets fab engineers know instantly when it's time for bath replenishment. This kind of process transparency makes for the most efficient use of expensive ultra-pure reactants and solvents while helping to curb toxic chemical waste.

- **Wet Etching**

Wafers are immersed in a bath of etchant solution—often diluted hydrofluoric acid—to remove SiO<sub>2</sub> or other extremely thin layers from the surface. The HF etch rate, described in Å/sec, must be held constant to avoid scrapped wafers, but the rate varies with HF concentration in the solution. Errors in etchant dilution ratio stem from improper initial mixing, residual water from previous rinses, and using a single bath with multiple acid ratios for different production recipes.

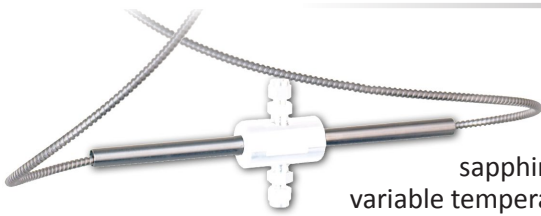
The fab equipped with an **OMA-300 SE** has a continuously reliable line of defense against etch rate drift. Tests using monitor wafers cost time and consumables and are too infrequent for true control. AAI's method analyzes etch bath composition with an accuracy of ±0.5 % full scale and the fastest response time in the UV-VIS-SWNIR industry.

- **Metal Ions**

As the semiconductor industry finds more use for metals in manufacturing, the need grows for proper analysis of metal ion concentrations in both process and waste streams. Monitoring trace metal allows for regulation of liquid plating processes. Beyond production, accurate measurement of copper, cobalt, and other ions in waste streams is critical for environmental compliance and water treatment control.

Monitoring metal ions at PPM levels is no challenge for the **OMA-300 SE**. This technology assists production but also helps its users embrace social responsibility.

## FAB INTEGRATION



### Flow Cell Interface

The flow cell design prioritizes compatibility with wafer production standards. The body (Teflon or PEEK) won't contribute any particle generation, and the sapphire optical windows are extremely resistant to acid corrosion. Designed for variable temperature and pressure, the flow cell is the only wetted element of the **OMA-300 SE**.

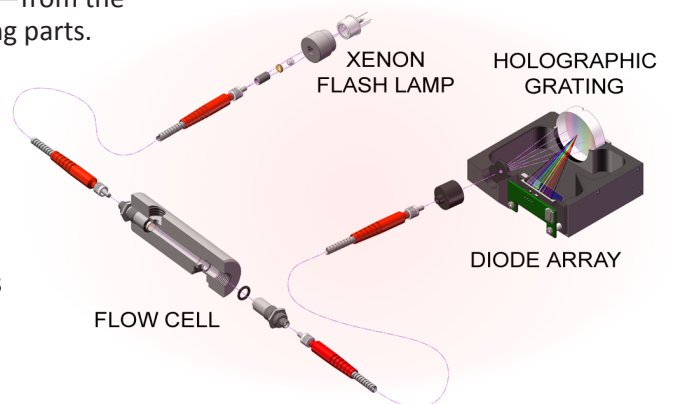
### Seamless Integration

Factory pre-calibrated per application, the **OMA-300 SE** defines turn-key. The instrument is entirely independent, with a dedicated industrial computer inside the enclosure for user interface and 4-20mA outputs for communication with the fab data network. Custom-length fiber optic cables (made in-house) allow for remote placement of the analyzer; distance from the process can be hundreds of meters to comply with cleanroom regulations. Engineered also for set-and-forget performance in closed-loop systems, the **OMA-300 SE** provides elegant feedback control—fully automating valves, spiking pumps, and alarms for real-time concentration management.

### The Analyzer

The **nova-II** spectrometer houses 1,024 photodiodes, each designated to detect a specific wavelength. Collecting light intensity data from all these diodes simultaneously, the analyzer continuously produces full UV-VIS-SWNIR spectra of sample absorbance at an ultra-fine resolution. This entire process—from the light source to the diodes—is instantaneous and involves no moving parts.

The **OMA-300 SE** performs interference-free, multi-component monitoring by processing high-res spectra with proprietary algorithms. The "over-determination" routine uses regression equations—with constants harvested from standard spectra—to de-convolute the individual components' absorbance from the composite. The software solves for the unknowns (analyte concentrations) using the additive absorbance data from hundreds of individual wavelengths simultaneously.



Protect your yield. Invest in your process. **AAI Technology**.

# OMA-300 SEMICONDUCTOR EDITION

# OMA-300 SEMICONDUCTOR EDITION | SPECIFICATIONS

## GENERAL PERFORMANCE

<b>Measurement Technology</b>	nova-II (UV-VIS-SWNIR diode array spectrometer)		
<b>Light Source</b>	pulsed xenon or tungsten lamp		
<b>Sample Introduction</b>	flow cell (low volume)		
<b>Measurement Range</b>	<b>SC-1</b> H <sub>2</sub> O <sub>2</sub> : 0-5 % wt NH <sub>3</sub> : 0-1 % wt H <sub>2</sub> O: 94-100 % wt	<b>SC-2</b> H <sub>2</sub> O <sub>2</sub> : 0-2 % wt HCl: 0-2 % wt H <sub>2</sub> O: 96-100 % wt	<b>Etch Bath</b> HF: 0-20 % wt <b>CMP Slurry</b> H <sub>2</sub> O <sub>2</sub> : 0-5 % wt
<b>Repeatability</b>	<b>SC-1</b> H <sub>2</sub> O <sub>2</sub> : ±0.1 % wt NH <sub>3</sub> : ±0-1 % wt H <sub>2</sub> O: ±0.5 % wt	<b>SC-2</b> H <sub>2</sub> O <sub>2</sub> : ±0.15 % wt HCl: ±0.15 % wt H <sub>2</sub> O: ±1.5 % wt	<b>Etch Bath</b> HF: ±0.5 % wt <b>CMP Slurry</b> H <sub>2</sub> O <sub>2</sub> : ±0.5 % wt
<b>Photometric Accuracy</b>	±0.004 AU		
<b>Detector Response Time</b>	0.2s		
<b>Calibration</b>	factory calibrated with certified calibration gases; for safety reasons, some applications require on-site or remote calibration		
<b>Verification</b>	easy verification/validation with standard certified gas samples and neutral density filters		

## SAMPLE CONDITIONS

<b>Temperature</b>	-20 to 150 °C (-4 to 302 °F)
<b>Pressure</b>	206 bar (3000 psi)

## HARDWARE

<b>Size</b>	analyzer: 24" H x 20" W x 8" D (610mm H x 508mm W x 203mm D)
<b>Weight</b>	32 lbs. (15 kg)
<b>Wetted Materials</b>	flow cell: Teflon or PEEK; sapphire windows
<b>Outputs</b>	one galvanically isolated 4-20mA output per component; modbus TCP/IP (optional); RS232 (optional); Fieldbus, Profibus, and HART (all optional); two digital outputs for fault, alarm, and sampling system control (user programmable)
<b>Electrical Requirements</b>	85 to 264 VAC 47 to 63 Hz
<b>Power Consumption</b>	45 watts
<b>Area Classification</b>	General Purpose (standard)

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