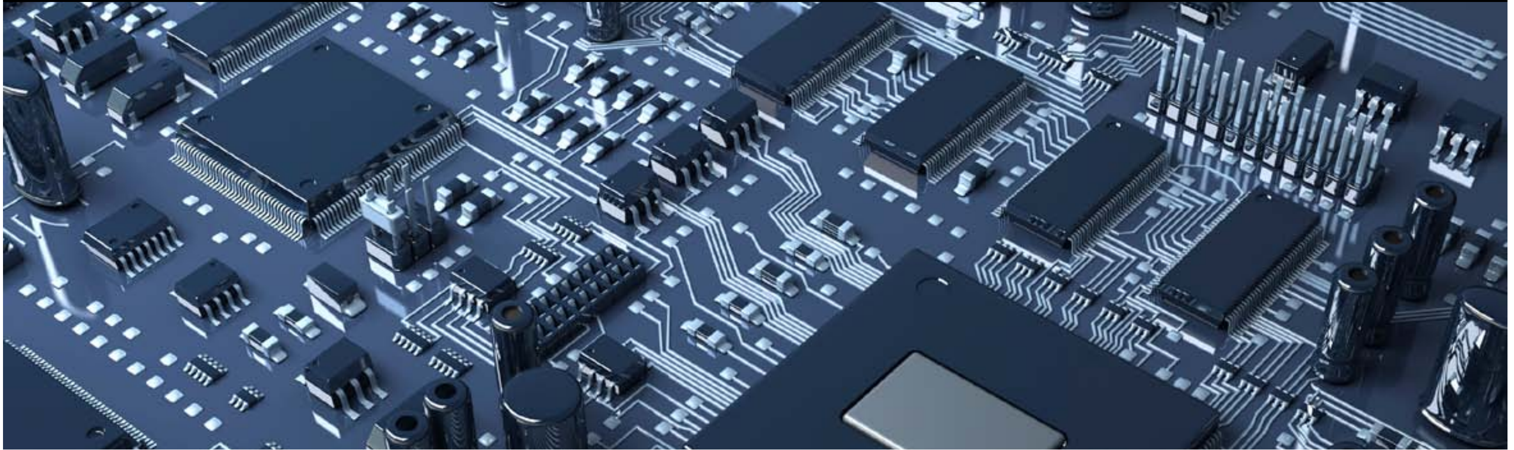
Semiconductor Fabrication Analysis Applications [OMA-300-SE]

Applied Analytics Application Note No. DS-001H — Revised 28 June 2013



Application Summary

Applications: CMP slurry health, SC-1 / SC-2 mixture composition, SPM composition, HF in wet etching bath, metal ions in electroplating / wastewater

Detector: OMA-300 Process Analyzer (using UV-Vis / SW-NIR dispersive absorbance spectrophotometer)

Introduction

The various acqueous 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 etching speed and cleaning efficiency.

The OMA system for semiconductor applications is aimed at a few distinct applications where continuous analysis is proven to improve yield or expedite processing.

OMA Benefits

» Continuously measures up to 5 chemicals' concentrations simultaneously using dispersive spectrophotometry

» Totally solid state build with no moving parts — modern design for low maintenance

» Ultra-safe fiber optic design with dedicated sample flow cell — no toxic/corrosive sample fluid in analyzer enclosure

» Flexible installation with fiber optics and remote access for easy integration into cleanroom environments

» Custom wetted materials for minimal particle generation or contamination

The Fab Environment

Semiconductor 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 the 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.

Chemical Mechanical Planarization (CMP) Slurries

CMP is used in fabs to polish the surface of silicon wafers and remove imperfections as layers of circuitry are deposited. Small drift in the composition of CMP slurries can lead 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. Delivery method, filtration type, and replenishment cycle are all significant causes for slurry degradation.

Solution: the **OMA** continuously monitors H_2O_2 concentration to validate the mixture within specification.

RCA Clean (SC-1 and 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 (for metallic contaminants), is made with a 1:1:6 ratio of HCl (37%), H_2O_2 (30%), and DI water.

Considering the chemical activity throughout the cleaning process and the evaporation occuring in an 80 °C bath, assuming these precise ratios to remain stable can be a costly misjudgment. When cleaning solutions drift from recipe specification, dangers include non-uniform wafer cleaning and increased wafer rework.

Solution: the **OMA** is perfectly suited for this application due to excellent multi-component analysis capability. The system monitors NH_3 and H_2O_2 concentrations continuously in an SC-1 sample to validate mixture ratios.

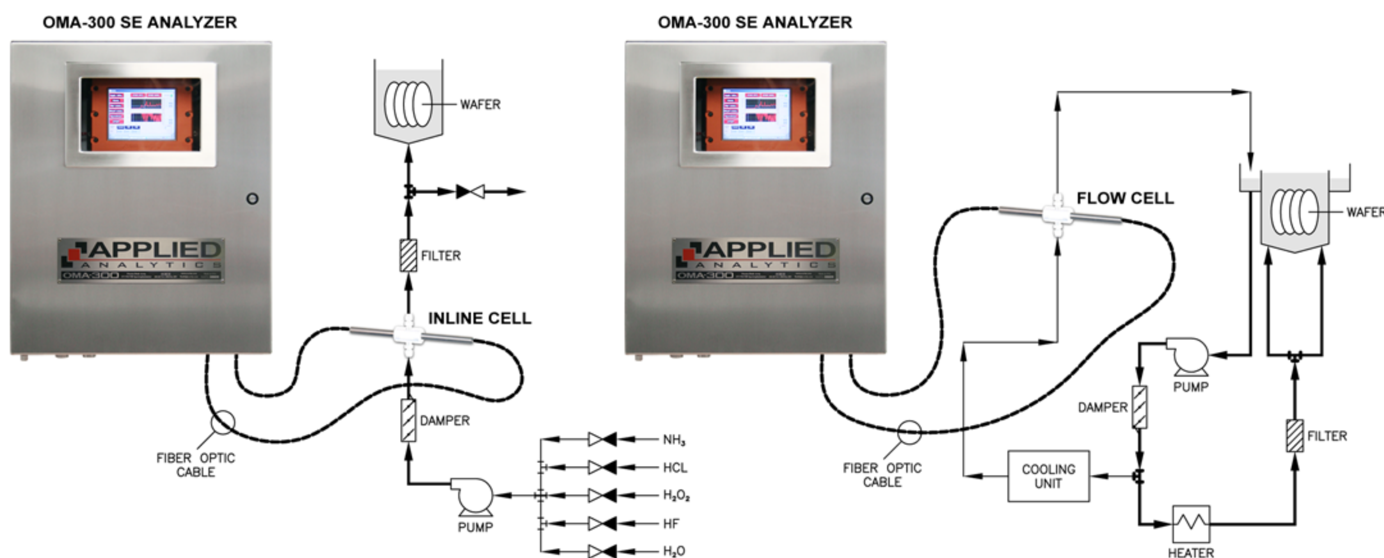
Hydrofluoric Acid in Wet Etching

Wafers are immersed in a bath of etchant solution—often diluted hydroflouric acid—to remove SiO_2 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.

Solution: the **OMA** continuously monitors HF concentration in the etching agent solution and provides an alarm output for when the sample ranges outside of specification.

Etching Bath Analysis Schematic

The schematic below demonstrates two different configurations for installing the sample flow cell:



Semiconductor Fabrication Analysis Applications [OMA-300-SE]

Applied Analytics Application Note No. DS-001H — Revised 28 June 2013

The specifications below represent performance/build of the OMA-300 Process Analyzer in typical semiconductor applications.

For technical details about the OMA-300 Process Analyzer, see the data sheet:
http://www.a-a-inc.com/documents/AA_DS001A_OMA300.pdf

All performance specifications are subject to the assumption that the sample conditioning system and unit installation are approved by Applied Analytics. For any other arrangement, please inquire directly with Sales.

Application Data			
Performance Specifcations			
Accuracy	SC-1	**H_2O_2**	0-5% wt: ±0.1% wt
		NH_3	0-1% wt: ±0.1% wt
		H_2O	94-100% wt: ±0.5% wt
	SC-2	**H_2O_2**	0-2% wt: ±0.15% wt
		HCl	0-2% wt: ±0.15% wt
		H_2O	96-100% wt: ±1.5% wt
	Etch Bath	**HF**	0-20% wt: ±0.5% wt
	CMP Slurry	**H_2O_2**	0-5% wt: ±0.5% wt
			(All measurement ranges can be customized)

Subject to modifications. Specified product characteristics and technical data do not serve as guarantee declarations.

Further Reading

Subject	Location
OMA-300 Process Analyzer Data sheet	http://www.a-a-inc.com/documents/AA_DS001A_OMA300.pdf
Advantage of Collateral Data Technical Note	http://www.a-a-inc.com/documents/AA_TN-202_CollateralData.pdf
Multi-Component Analysis Technical Note	http://www.a-a-inc.com/documents/AA_TN-203_MultiComponentAnalysis.pdf

is a registered trademark of Applied Analytics Group BV. | www.a-a-inc.com

Headquarters + Manufacturing
Applied Analytics, Inc.
Burlington, MA | sales@a-a-inc.com

North America Sales
Applied Analytics North America, Ltd.
Houston, TX | sales@appliedanalytics.us

Europe Sales
Applied Analytics Europe, SpA
Milan, Italy | sales@appliedanalytics.eu

Asia Pacific Sales
Applied Analytics Asia Pte. Ltd.
Singapore | sales@appliedanalytics.com.sg

Middle East Sales
Applied Analytics Middle East (FZE)
Sharjah, UAE | sales@appliedanalytics.ae

Brazil Sales
Applied Analytics do Brasil
Rio de Janeiro, Brazil | sales@aadbl.com.br

India Sales
Applied Analytics (India) Pte. Ltd.
Mumbai, India | sales@appliedanalytics.in

© 2013 Applied Analytics Group BV. Products or references stated may be trademarks or registered trademarks of their respective owners. All rights reserved. We reserve the right to make technical changes or modify this document without prior notice. Regarding purchase orders, agreed-upon details shall prevail.