Vapor Phase Decomposition ICP-MS

Wafer Surface Metal Contamination

A major requirement for front end processing is low surface metal contamination prior to thermal processing and gate oxide growth. Alkali metals can cause MOSFET threshold voltage shifts, Al and Zn affect the oxidation rates of silicon, and Fe, Cr, and Cu can cause junction leakage currents and gate oxide integrity (GOI) degradation. In addition, metals can cause surface and interface micro-roughening and form silicides.

One of the most sensitive surface analytical techniques for metals on wafers is vapor phase decomposition inductively coupled plasma mass spectrometry (VPD ICP-MS). VPD ICP-MS is the method of choice because:

- It is an elemental survey technique that can detect low-z and high-z elements in one analysis
- It provides detection limits for 450 mm wafers as low as 1×10^6 atoms/cm^2 for select elements
- Whole 450 mm and smaller wafers can be analyzed without breaking the wafer

VPD ICP-MS Process

Vapor Phase Decomposition (VPD)

- The wafer is exposed to moist HF vapor that dissolves all oxides on the wafer surface

Drop Scan Collection

- The wafer is scanned with a controlled droplet of dilute high-purity acid
- The acid droplet collects all contaminants from the HF decomposed surface oxide
- The droplet can scan the front and backside of wafers
- Standard list of metals and noble metals may be analyzed from the same wafer

Collection Droplet Analysis

- The droplet is then analyzed for elemental contamination by ICP-MS

Analysis Environment

- Customized VPD chamber is housed in a Class 10 cleanroom with the ICP-MS instrument located in a separate Class 10 cleanroom.

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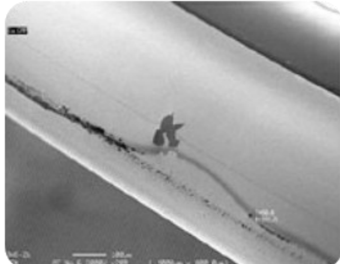
Tool Contamination Evaluation and Qualification

Witness wafers are used to monitor in-tool metal contamination present as surface molecular contamination that lands on the wafer or from contact with wafer handler components.

Bevel-Edge Scan

The bevel and edge scans may be used to evaluate the wafer cleanliness from contact with wafer handlers, new or retrofitted systems, or with wafer carriers.



Wafer bevel showing defect

Edge-grip and ring seal handler.

- End-effector is designed to grasp wafers with a talon-like device that effectively grips the wafer without effecting contact of the wafer surface front or backside

Wafer flip module

- Used for coatings, backings, etches, rinses and inspection of wafer backside

Wafer edge defect

- Successive byproduct layers may peel or flake off from the edge of the during wafer transportation thereby contaminating other substrates in the wafer carrier

Radial Scan

The radial scans provide localized information of surface metal contamination at specific radial distances from the center of the wafer.

Wafer chuck and heat/cool pedestal assembly

- Ring or pin contacts offers a significant decrease in the surface contact area on the wafer backside; lift pin may contaminate the wafer surface

Electrostatic chuck (ESC)

- These are ultra-flat, high-purity ceramic chucks that are three to five times stiffer than glass or metal alternatives. ESCs are composed of specialized materials making them challenging to clean.

Vacuum chuck

- Metal sources may arise from materials (new and cleaned) and new coatings used in the tool

Bevel-Edge Scan

Radial Scan

Zone 4
Zone 3
Zone 2
Zone 1

Balazs™ NanoAnalysis operates ISO 17025 certified laboratories that identify, analyze and resolve contamination issues for high-tech industries around the world. The Microcontamination Experts™ at Balazs provide rapid and accurate analyses and expertise for water, air, chemicals, process gases, components, wafers, consumables and any other contamination sources.

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