Don't Forget the Edge!
Significance of VPD ICP-MS Edge Exclusion

BALAZS™ ANALYTICAL SERVICES

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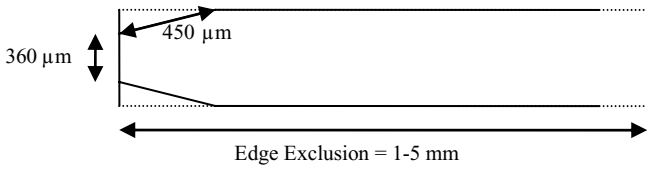
VPD ICP-MS (Vapor Phase Decomposition followed by ICP-MS analysis) is an analytical technique gaining momentum as an important method used to measure trace metal surface contamination on wafer surfaces. Historically, TXRF has been used to analyze surface metal contamination since many facilities have TXRF equipment available in-house, providing quick results. However, VPD offers distinct advantages, making it a more thorough technique. Compared to TXRF, VPD provides results for the entire mass spectrum including lithium and boron, offers lower detection limits and has the ability to analyze the entire wafer surface.

During VPD, the native or thermal oxide wafer surface is dissolved using HF vapors that react with the metal impurities in the oxide layer to form soluble fluorides. Then, a known volume of collection solution is placed on the wafer. The droplet is maneuvered over the wafer surface (scanning) to collect the metal impurities. After scanning, the collection solution is analyzed via ICP-MS resulting in data that represents the total surface metal contamination of the wafer surface.



Scanning the wafer surface involves several different patterns to ensure the entire wafer surface is covered and all metal impurities are collected. Common industry practice includes a 5mm edge exclusion, meaning that the collection solution does not come within 5mm of the wafer's edge.

Balazs has developed a technique to analyze the entire wafer surface and has recently conducted experiments to identify the significance of excluding the wafer edge and the results were, well, significant. The data (Table 1) shows four wafers from the same lot and process comparing a 5mm edge exclusion versus including a 0mm edge exclusion.

Element	Detection Limit	Control Solution	NO Edge Exclusion	NO Edge Exclusion	5 mm Edge Exclusion	5 mm Edge Exclusion
	(atoms/cm^2)	(atoms/cm^2)	(atoms/cm^2)	(atoms/cm^2)	(atoms/cm^2)	(atoms/cm^2)
Aluminum	6.89E+ 08	< DL	1.34E+ 10	9.85E+ 09	1.89E+ 09	1.70E+ 09
Calcium	4.64E+ 08	< DL	1.28E+ 09	4.50E+ 09	< DL	< DL
Iron	3.33E+ 08	< DL	1.30E+ 10	5.02E+ 09	3.62E+ 09	3.74E+ 09
Potassium	4.75E+ 08	< DL	2.54E+ 09	8.17E+ 09	< DL	< DL
Sodium	8.08E+ 08	< DL	9.48E+ 09	1.96E+ 10	9.17E+ 08	< DL
Zinc	1.42E+ 08	< DL	3.12E+ 09	< DL	< DL	< DL

Table 1: Surface metal contamination data via VPD ICP-MS

As high technology processes have metal specifications less than 1E10 atoms/cm^2 one can see from the data that the contamination on the edge of the wafer is near or above this limit. Contamination levels above or close to the specification for metals such as sodium, potassium, aluminum, iron, and zinc can be detrimental to IC device operation.

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Most contamination on the edge of a wafer comes from the wafer boat and handlers within the fab that come into contact with the edge of the wafer. Regardless, this contamination is capable of migrating to other locations on the wafer as processing continues and may lead to device defects.

VPD analysis at Balazs is offered with no edge exclusion. Collecting this additional data provides an accurate report of total surface metal contamination while offering insight into contamination sources within the fab. By knowing and understanding the kind of contamination in the edge exclusion, contamination becomes better understood and easier to control. To ensure a complete contamination picture it is important for one to know how their lab is performing VPD.