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Development of fully automated in-line VPD-ICP-MS – Sungjae Lee

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. In semiconductor manufacturing, trace contamination on the wafer surface can have a negative impact on device lifetime, functionality, and performance.

A common method for tool-level contamination monitoring is the analysis of surface contamination deposited on test wafers processed through the tool. Several techniques can be employed to identify wafer surface contamination and its source. The VPD technique combined with ICP-MS or total reflection x-ray spectrometry (TXRF) are very useful monitoring methods for ultra-trace detection of surface metallic contamination. With VPD TXRF, elements ranging from sulfur through uranium with low detection limits and masses below 28 amu with higher detection limits can be analyzed. VPD ICP-MS offers better detection limits than TXRF for most analytes and also permits the analysis of critical elements into semiconductor manufacturing process such as lithium, boron, aluminum, sodium, and magnesium. Moreover, VPD ICP-MS allows for direct calibration with certified standards, while the TXRF have been many standardization issues for quantitative analysis.

The VPD process exposes the wafer to HF vapor, and then a droplet of acidic solution scans the wafer to collect the metals from the dissolved surface oxide. This solution is then analyzed for metals by ICP-MS. The best detection limits are extended down to 1E5 atoms/cm2.

But the VPD-ICP-MS technique has been used in a lab (outside of the clean room used to process wafers) and it takes usually hours, or even days, after the process step caused the contamination.

In order to overcome this issue, a new in-line VPD technology combination with ICP-MS has been developed. The new technology uses a specialized scan nozzle and additional VPD chemistry developed for preparation of various films such as a thick nitride film, e.g. 200nm, and a poly-silicon film. The integration with ICP-MS allows fully automated operation of continuous monitoring metallic impurities at the level of 1E5 atoms/cm2.

The main advantage of this in-line VPD-ICP-MS technique was the capability to provide fast and reliable inspection results that would be used in various research projects such as the introduction of new materials into the process flow, the continuous monitoring of new process tools, and the change in process condition from new technologies.

This paper represents the results obtained with the new in-line VPD-ICP-MS system used in a FAB.

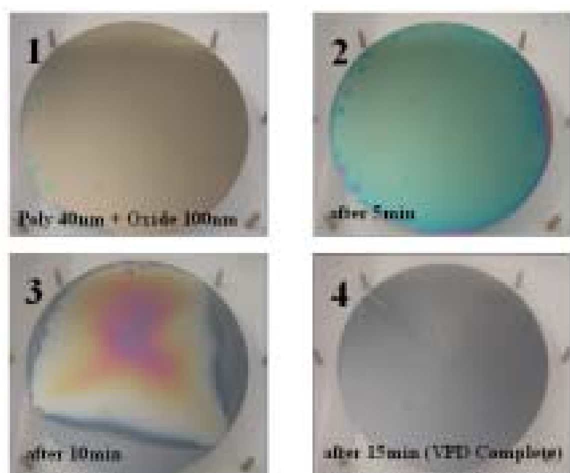

Fig.1 Decomposition of Poly-Silicon 40nm film by new VPD chemistry.