

QUANTIFICATION ISSUES OF TRACE METAL CONTAMINANTS ON SILICON WAFERS BY MEANS OF TOF-SIMS, ICP-MS AND TXRF

P. Rostam-Khani, P. Vullings, G. Noij,
O. O'Halloran, W. Claassen
Philips Semiconductors BV

Gerstweg 2, 6534 AE Nijmegen, The Netherlands
patrick.rostam-khani@philips.com

Measurement of surface metal contamination on silicon wafers is essential for yield enhancement in IC manufacturing. VPD-ICPMS, VPD-TXRF, TXRF and, more recently, TOF-SIMS are used to monitor surface metal contamination. These techniques complement each other in their respective strengths and weaknesses. TOF-SIMS is a relatively new technique for analyzing contaminants on wafer surfaces in a routine laboratory environment. It is a versatile method that offers a wide field of application especially in the semiconductor technology (organic contamination, particles, imaging, depth profiling). For reliable and accurate quantification so-called relative sensitivity factors (RSF) are required. For quantification purposes in VPD-TXRF and VPD-ICPMS the collection efficiency (CE) is important to ensure complete collection of contamination.

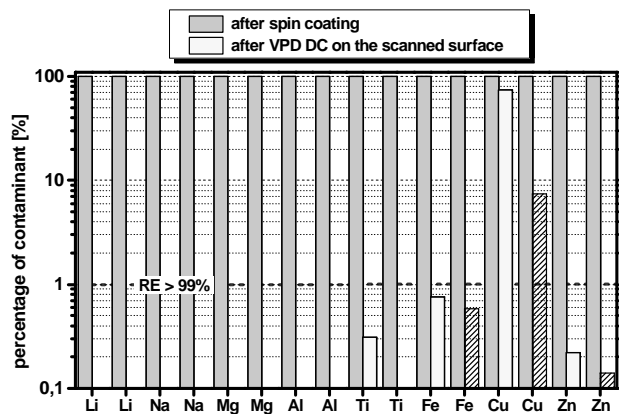


Figure 1: Removal efficiency (RE) for selected elements determined by TOF-SIMS. For the low z elements < 0.1 % of the original surface coverage has been found on the scanned surface and therefore this is not visible on the logarithmic scaled figure. The hatched bars show the results for peroxide containing DSE solution whereas for the light gray bars diluted HF has been used.

In the Process & Materials Analysis department a standard procedure has been developed that combines the determination of these RSF factors as well as the collection efficiency using all the analytical techniques mentioned above. Therefore sample wafers were intentionally contaminated by spin coating using several elements at different concentrations and analyzed directly after preparation by TOF-SIMS. The wafers were exposed to HF, scanned and after collection the droplet was analyzed by ICP-MS. Several scanned surfaces were then analyzed by

TOF-SIMS. Comparing the normalized intensities of the specific metals before and after the VPD-DC procedure on the scanned surface allows the determination of so-called removal efficiency (RE) (figure 1) by the collection liquid. If no further metal traces are added or lost during the whole VPD procedure RE and CE are identical.

In general very good agreement was obtained comparing the three analytical techniques after update of RSFs (figure 2). Progress has been achieved concerning the CE evaluation as well as determining the RSF factors more precisely for TOF-SIMS. Further elements will be investigated in order to cover almost the whole periodic system. The presentation will show the TOF-SIMS measurement procedure, the comparison with VPD-ICPMS, VPD-TXRF and TXRF in more detail, and it will also show selected problems from the daily routine where VPD-ICPMS and TXRF failed as well as enhanced each other.

REFERENCES

- [1] F. Zanderigo, S. Ferrari, G. Queirolo, M. Borgini, Materials Science and Engineering B, **73**, 173 (2000)
- [2] P. Lazzeri, A. Lui, L. Moro, L. Vanzetti, Surface and Interface Analysis, **29**, 798 (2000)

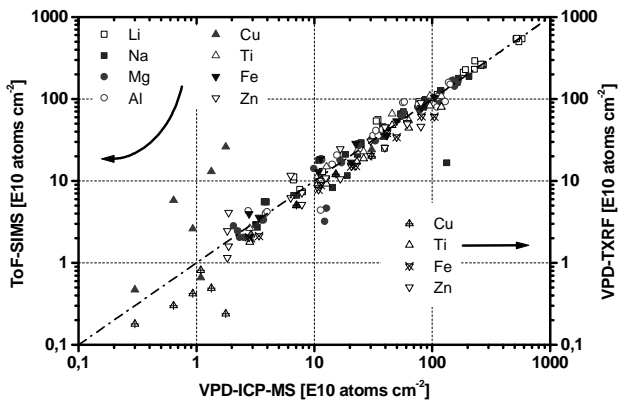


Figure 2: Comparison of the surface fractions from TOF-SIMS and VPD-ICP-MS as well as VPD-TXRF if applicable for selected elements. The values for copper are not corrected to incomplete collection during the VPD process.