Improvement of Calibration Processes in TXRF of Wafer Surface Analysis: Investigation of Saturation Effects in TXRF by Comparing Picodroplets and Microdroplets

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One of the major problems for standardization of TXRF for wafer surface analysis is the large statistical uncertainty of quantification. The presented work intends to improve the statistical quality of TXRF quantification by investigating the sample parameters (e.g. shape, density) and their influence on absorption effects and hence the fluorescence intensity.

In general TXRF is known to allow linear calibration typically using an internal standard for quantification. For small sample amounts (low ng region) the thin film approximation can be applied and hence absorption effects of the exciting and the detected radiation are neglected. For high total amounts of samples, deviations from the linear relation between fluorescence intensity and sample amount have been observed (saturation effect). These are not directly linked to a loss of validity of the calibration with internal standard, but lead to difficulties in absolute quantification or external standard quantification.
The topic of the presented work is an investigation of the saturation effect by comparing the fluorescence intensities emitted by samples with different shapes. Two different types of sample series have been prepared – one series contained samples consisting of a pattern of picodroplets and the other series contained single microdroplet samples. In contrast to microdroplets picodroplets have a well defined shape. A lower saturation effect was expected for the picodroplet samples. The samples of each series contained different amounts of nickel covering a range from low total sample amounts (0.6 pg) to very large amounts (292 ng) which are typically not used in TXRF. The element nickel was chosen for this investigation because it is usually used as reference standard for calibration of TXRF wafer analyzers in the semiconductor industry.

The fluorescence intensities emitted by these samples were both measured and calculated to determine the upper limit of sample mass where the linear relation between fluorescence intensity and sample amount is no longer guaranteed. The measurements were done with an Atomika 8030W waferanalyzer and compared to calculations performed with a self-developed simulation model.