The Effect of Integrated Metrology on Litho Performance

R.B.J. van Os, A.J. de Ron, and J.E. Rooda
Eindhoven University of Technology
Department of Mechanical Engineering, Systems Engineering Group
http://se.wtb.tue.nl

Introduction

The semiconductor industry is a capital-intensive and highly competitive industry. To remain profitable and competitive semiconductor manufacturers have to make innovations in their fabrication process all-year round. This is especially important in the lithographic process step, which is the bottleneck step in chip fabrication. One of the future innovations is the integration of metrology tools into the lithographic processes, concentrated in the lithocell, in stead of doing offline measurements. The industry thinks that integrated metrology (IM) contributes to an earlier detection of process excursions. When a process excursion occurs, all processed wafers will be non-qualified until it is detected and corrected.

Objectives

This research aims to compare the effect on performance by using integrated and offline metrology, where the lithographic processes are liable to process excursions. Performance is graded with respect to throughput $\delta$ and flow time $\varphi$.

Approach

Using the concept of Effective Process Time (EPT) [1], relations have been derived that quantify the effect of process excursions on throughput performance. The throughput of the systems depends on the lithocell, which has a multiple lot character. A multiple lot machine can be described as a single lot machine with a mean EPT $\mu_1$ and squared coefficient of variation $c_{e1}^2$ followed by an infinite server with mean EPT $\mu_2$. The EPT parameters $\mu_1$ and $c_{e1}$ represent respectively the effective throughput $\delta$ and the variability of the different systems. Based on this knowledge, basic queueing relations [2] are adapted. This results in Equation 1 and 2, which quantify $\varphi$ for respectively the system with integrated and offline metrology.

\[
\varphi = \frac{c_{e1}^2 + c_{e2}^2}{2} \frac{u}{1-u} (\mu_1 + \mu_2 + \mu_3)
\]

\[
\varphi = \frac{c_{e1}^2 + c_{e2}^2}{2} \frac{u}{1-u} (\mu_1 + \mu_2 + \mu_3 + t_i + t_q)
\]

The transport time $t_i$ is used to make a distinction between different offline practices. The offline measurement time is denoted by $t_q$.

Results

The performance of the systems with integrated and offline metrology is compared using the derived relations. The effect of process excursions, represented by the time between two process excursions $t_i$, is quantified by the effective throughput $\delta$.

Conclusions

The system with IM contributes to a better performance of the litho area compared to offline metrology. This is mainly due to elimination of transport time and therefore an earlier detection of process excursions. The influence of process excursions is almost negligible when using IM. However, their effect becomes significant when they occur often in a system with offline metrology.

References
