# ASSESSMENT OF IP ERROR COMPENSATION TECHNIQUES FOR EUVL

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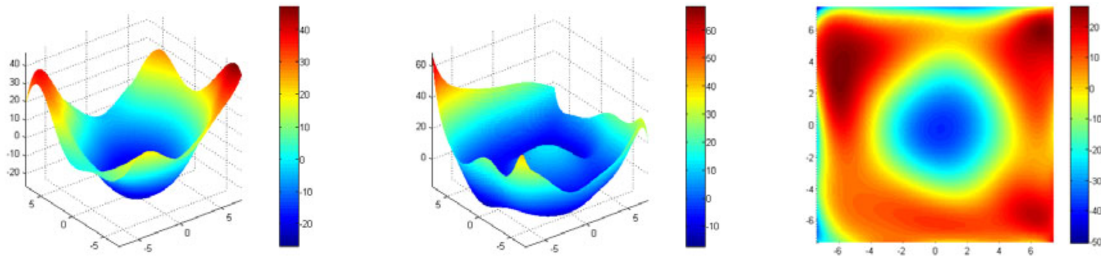
## ABSTRACT

According to the International Technology Roadmap for Semiconductors, meeting the overlay requirements for the sub-32-nm regime is a difficult challenge for all future lithography technologies. For Extreme Ultraviolet Lithography, the nonflatness of both the mask and chuck contribute to overlay error by way of image placement (IP) errors. Consequently it has been proposed to compensate for these IP errors induced by mask fabrication and chucking, by employing correction schemes during the e-beam writing process.

This study presents an assessment of various IP error compensation techniques currently being considered by the semiconductor industry. To carry out a detailed analysis, an actual substrate with measured initial nonflatness (due to polishing errors) was used as shown in Fig. 1. Unique finite element (FE) and analytical models have been developed for this research to identify the sources of IP errors. Typical examples were used to determine the effects of thin-film deposition and etching, reticle and chuck nonflatness, and the chucking process itself. The FE and analytical models have been compared at each processing step and the corresponding effects on IP accuracy have been studied in detail. The neutral surface of the mask substrate, an important factor affecting the IP errors, was tracked both numerically and analytically to determine the sources of variation in the estimation of in-plane distortions (IPD). The pattern transfer IPD within the quality area, estimated by the FE and analytical models is shown in Figs. 2 and 3, respectively. The results indicate a good correlation between the two models. The shortcomings and advantages of implementing these techniques as an e-beam correction strategy are also presented. It is shown that under certain conditions, the analytical model closely replicates the results of the full FE model.



*P*-*V* = 74 nm
RMS = 16 nm

(a)

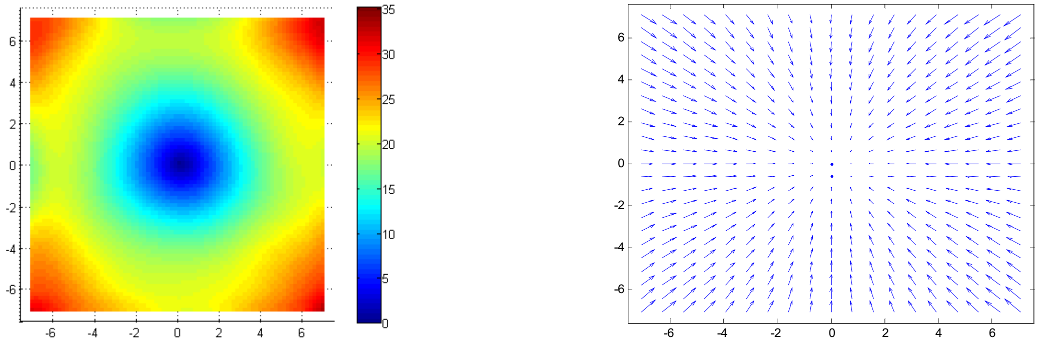
*P*-*V* = 86 nm
RMS = 12 nm

(b)

Max. = 77 nm

(c)

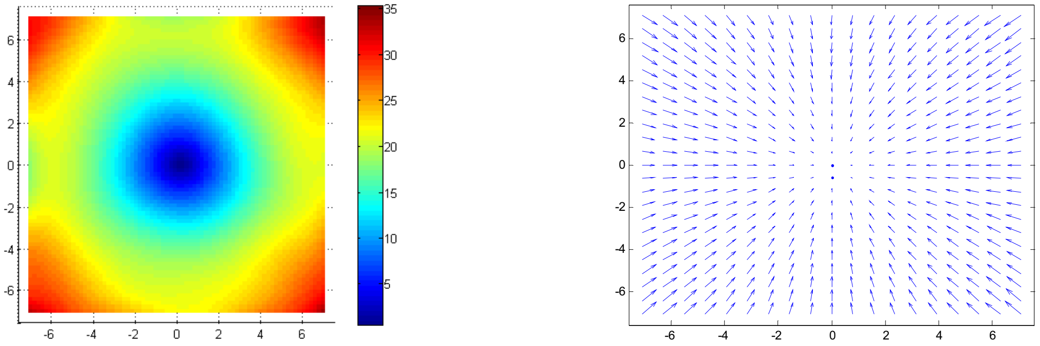
**Fig. 1.** **Surface shape results for the EUVL substrate (before thin film deposition), illustrating the (a) frontside surface plot, (b) backside surface plot, and (c) thickness variation plot.**



(a)

(b)

**Fig. 2.** **(a) Contour plot and (b) vector map of pattern transfer IPD as calculated by FE simulations. Maximum IPD is 34.2 nm within the Quality Area.**



(a)

(b)

**Fig. 3.** **(a) Contour plot and (b) vector map of pattern transfer IPD as determined by analytical calculations. Maximum IPD is 35.2 nm within the Quality Area.**