Model based OPC runtime saving with multi-segment solver

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Modern photolithography is approaching closer to the resolution limit of the optical system, which implies a bigger image distortion between the mask and the silicon wafer. To improve the layout printability on silicon wafer, model based optical proximity correction (MBOPC) has been widely adopted by making mask pre-compensation of all nonlinear effects, optical diffraction and resist and etch effects. Before MBOPC is performed across a full chip, a process model is calibrated based upon manufacturing process data measured from SEM pictures of test patterns. After the model calibration, a recipe is written to conduct the mask corrections, during which the polygons in the layout are dissected into different segments. On each of the segment, the signal and threshold are simulated by the model. If the simulated contour, determined by the intersection between signal and threshold, on the wafer does not match the desired one, the mask is perturbed by adjusting the size of the segment till it meets the target.

While it is relatively easy and straightforward to find the optimized segment size for most 1D features, it is hard for many 2D features, especially line-end structures. By solving a few segments around line-end areas together, multi-segment solver (MSS) showed a good contour match. One example is shown in figure 1, in which the correction results (red) with and without MSS are compared side by side. MSS helps reduce the line-end edge placement error (EPE) to 8.5 nm from 12.5 nm after first iteration during the correction process. However, this method is expensive on model calculation, as there is more than one segment size to be optimized and massive search is needed.

In this study, a novel method of computing the signal change in MBOPC process with MSS turned on is proposed, which can save the MBOPC runtime significantly. In the new method, the kernel sensitivity of the calibrated model is analyzed before the model is applied to MBOPC and only the most sensitive kernels are picked for computing the mask perturbation. The full model is still adopted for the signal calculation on the main patterns so that the accuracy of MBOPC remains unchanged. Some preliminary correction results generated with the new method are compared with those generated by the traditional method, as shown in figure 2. The EPE difference between the traditional and new methods is only 1 nm or so and the MBOPC runtime has been reduced from 1632 s to 1026 s.

The detailed explanation on the new method and analysis on the kernel sensitivity will be discussed in the full paper.

Fig. 1. Comparison of the MBOPC results with and without MSS after first iteration. The contours at line-end are significantly improved with MSS turned on.

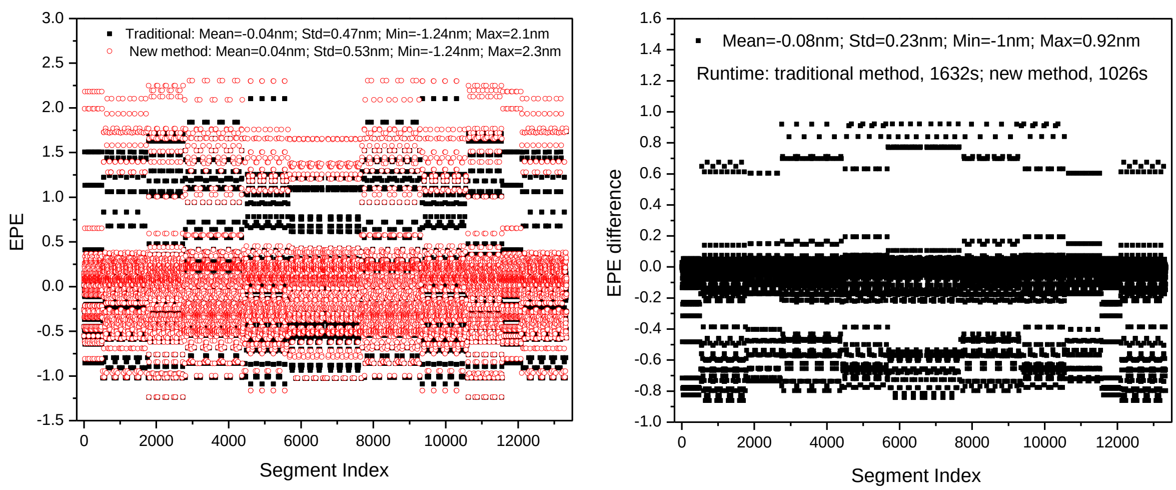

Fig. 2. MBOPC correction results with the traditional method (black squares) and the new method (red circulars). The sub-nanometer EPE difference (right hand side) indicates that these two methods yield close results and are comparable.