Source Imperfection Impacts on Optical Proximity Correction

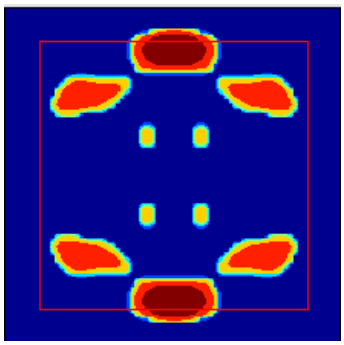
Lawrence S. Melvin III, Artak Isoyan
Synopsys, Inc. 2025 NW Cornelius Pass Road, Hillsboro, OR 97124, United States
e-mail: lmelvin@synopsys.com

Jensheng Huang
Synopsys, Inc. 690 E Middlefield Rd., Mountain View, CA 94043, United States

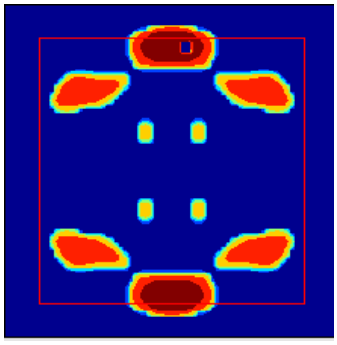
Programmable illumination sources have helped enable the continued shrinkage of semiconductor feature sizes well below wavelength. This transformative technology is the result of a pixelated illumination system and computational lithography that match the best source shape, Optical Proximity Correction (OPC), and Resolution Enhancement Technique (RET) to a given drawn pattern, a process referred to as Source Mask Optimization (SMO). The result is a mask pattern and source shape that together image a process layer. While the math and computation can produce highly accurate results, the physical implementation, as in any physical system, has error associated with it. This paper proposes to study the effect of source imperfections on the final wafer pattern using simulation techniques.

Source imperfections due many issues such as lifetime effects and tolerance drifts can reduce the effectiveness of the optical system designed computationally. If the optical system is measured and modeled, then measurement uncertainties may also be introduced into the system during model creation. These differences between the measured and computed sources can then be exacerbated by computational assumptions such as symmetry that are used to reduce computation time.

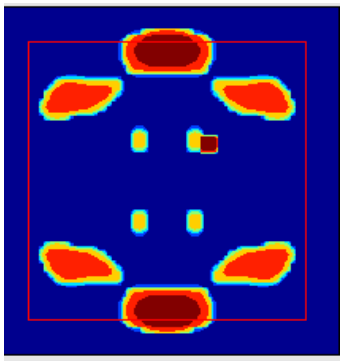
This paper will study the impact of source imperfections on a final corrected pattern using computational techniques. The study will vary a single defect's position, magnitude, and size across one quadrant of a parameterized source. These varied sources will then be used to simulate and correct a pattern, then compare the results to the ideal source. This will study will quantify the impact of source variations on the final pattern and present them.



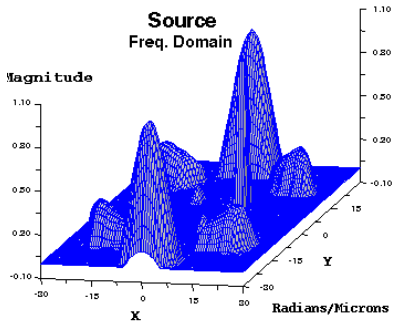
a)



b)



c)



d)

Figure a is a nominal source. Figures b and c are the nominal source with an induced error. Figure d is a frequency domain representation of figure c.