Application of Kernel Convolution for Complementing Source Mask Optimization

Marshal A. Miller, Kenji Yamazoe*, and Andrew R. Neureuther
UC Berkeley, 271 Cory Hall, Berkeley CA 94704
*UC Berkeley and Canon Inc., Japan
510-642-9646

Kernel convolution with Pattern Matching (KCPM) [1] is shown to be an effective complementary fast-CAD tool for post or real-time quantitative assessments of the robustness and richness of the source-mask-optimization (SMO) solution. Full optimization quickly becomes prohibitively expensive and there is a balance to be found between including many physical effects (process window, aberrations, resist, polarization, mask edge effects) and over-optimization. For example, it has been reported [2] that optimizing over many layouts will not converge to a standard source, making it important to decide how to combine or choose among possible sources.

This paper first illustrates the speed and accuracy of KCPM for complementing SMO. KCPM is evaluated for typical problems of through-focus modeling and source realization tolerances. For reasonable levels of defocus and other aberrations, KCPM is accurate to within +/- 2% of the clear field intensity compared to full aerial imaging, with typical source variations. The paper then explores real-time interoperable use of SMO with various scenarios for cost-functions and speeds-ups through co-sharing critical worst-case locations in layouts. For example, for an effect such as defocus, KCPM calculates a match factor indicating a measure of the sensitivity to defocus errors. This value can be used as a term in the cost function to improve pattern robustness, or as a flag if the pattern sensitivity drops below acceptable process tolerances. Finally, post-SMO applications will be explored for including multiple sources for a given layout and multiple layouts for a given source. Here, typical layouts for SRAM design variations and standard cell layouts for logic functions will be used.

[1] Marshal A. Miller, Kenji Yamazoe, and Andrew R. Neureuther, “Extensions of boundary layer modeling of photomask topography effects to fast-CAD using pattern matching,” Proc. SPIE, Vol. 7488, 74883H (2009).
[2] Kehan Tian, et. al., “Benefits and trade-offs of global source optimization in optical lithography,” Proc. SPIE, Vol. 7274, 72740C (2009).