Mask Design for Resolution Enhancement: An Inverse Problem in Optical Microlithography

Amyn Poonawala
Computer Engineering, University of California, Santa Cruz
amyn@soe.ucsc.edu

Abstract

Optical microlithography, a technique similar to photographic printing, is used for transferring circuit patterns onto silicon wafers. The above process introduces distortions arising from optical limits and non-linear resist effects, leading to poor pattern fidelity and yield loss. The input to the above system is a photo-mask (or reticle), which can be controlled (or engineered) such that it cancels out (or compensates for) the process losses to come. This forms the basis of optical proximity correction (OPC) and phase shift masks (PSM), two commonly employed resolution enhancement techniques (RETs) for patterning very small features (close to the optical limit). In this talk, we discuss a novel inverse lithography technology (ILT) framework to synthesize OPC and PSM for high-fidelity patterning of random logic 2-D features. ILT attempts to synthesize the input mask which leads to the desired output wafer pattern by inverting the mathematical forward model from mask to wafer. Our framework employs a pixel-based mask parameterization, continuous function formulation, and analytic gradient-based optimization techniques to synthesize the masks. We also introduce a regularization framework to control the tone and complexity of the synthesized masks, and inculcate other user-defined properties. The results indicate automatic generation and placement of assist bars, which are very popular in the semiconductor industry. We conclude by briefly discussing ILT-based mask

design for double exposure lithography systems, which are deemed as key technology enablers for the future.