The Effects of Off-Axis Illumination and Scattering-Bar Optical Proximity Correction on the Impact of Lens Aberration on 130nm Poly Gate Mask - A Simulation Study

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ABSTRACT

A simulation study has been performed to look at improving the imaging of a 130nm poly gate mask design. For this lithography process, we have chosen 6% attenuated PSM applied with scattering-bar optical proximity correction (SB-OPC) using 248nm exposure wavelength. We compared the process window performance of off-axis illuminations (OAI) such as QUASAR and annular to a conventional on-axis illumination. Sampled lens aberrations were introduced to the simulation model to evaluate the impact of illumination settings. Simulations show benefits of combining SB-OPC technology with OAI on the performance of 130nm poly gate line features in the presence of known lens aberrations. For this simulation study, we have used our WaveMaster™ software tool to automate the SOLID-C™ simulation loops that includes multiple pre-selected line features from an actual poly gate mask design, five different lens aberration Zerneke data sets, and three illumination settings.

Key Words: CD, Process Window, Scattering Bars, SB, Optical Proximity Correction (OPC), Attenuated PSM, Off-Axis Illumination (OAI)

1. INTRODUCTION

The key to successful sub-wavelength lithography depends on how the process can be best optimized. This optimization process includes not only understanding mask, resist, and wafer effects, but also the impact of the exposure system. At near half of exposure wavelength, to achieve a production-worthy lithography process one will have to account for all of these effects. The use of simulation has shown to be very effective in the evaluation of process optimization and control.

Recently a significant attention has been placed on the issues of lens aberrations. This is because at near half of the exposure wavelength, relatively small lens aberrations (in the neighborhood of ±10nm) could cause the already small the process window to shrink even smaller which is likely to become unfeasible for manufacturing. It has been proposed that the use off-axis illumination (OAI) can balance the impact of lens aberration on CD performance. [1] Using scattering-bar optical proximity correction (SB-OPC), it is possible to minimize the sensitivity of lens aberrations. [2] We feel that combining the two and with 6% attenuated PSM, a robust lithography process could be possible for 130nm generation.

This report is intended to demonstrate a proposed methodology to use simulation as a verification of method tool to look at improving the imaging of 130nm poly gate line features. Lens aberration was introduced to the simulation model to evaluate the impact of illumination sources on minimizing aberration effects to the process window. The goal was to determine if the impact of minute lens aberration could be minimized through a combination of OAI, PSM, and SB-OPC. To automate such an investigation process, we have used our WaveMaster™ software tool to loop control SOLID-C simulation for multiple pre-selected line features from an actual poly gate mask design, five different lens aberration Zerneke data sets, and three illumination settings.

2. SIMULATION CONDITIONS

Two different mask pattern designs (both from the same mask) were studied, simulating a typical SRAM cell and logic design (see Figure 1). All linewidths were 130nm. Several cut lines were defined for use in simulation (4 cut lines for the SRAM, 9 cut lines for the logic) to evaluate pitch performance and orientation relative to lens aberrations (Figure 2). The

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