Exposure dose for targets and large areas

This Application Note briefly describes methods for determining the base dose for a process and different strategies to get structures on target. Among the alternatives are compensation via biasing or introduction of a uniform clearing for the resist.

INTRODUCTION

The base dose of a process is defined as the required dose to expose a large grating at 50% density and remove the photoresist. This means that the grating is completely cleared from the resist. However, the dose modulation implemented by proximity effect correction (PEC) tends to lower the exposure dose applied to the structures. As a consequence, the critical dimension (CD) of the grating is not on target (see Fig. 1), and the resist remains in regions where the dose is lower than the base dose (see Fig. 2).

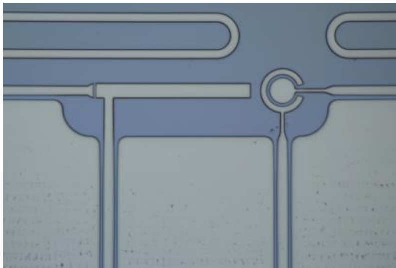

Figure 1. Widened waveguides when using the right base dose during exposure.

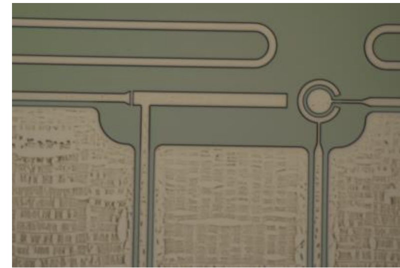

Figure 2. Resist remaining on the design due to PEC base dose lowering during exposure.

To address the challenges posed by PEC and achieve desired CD targets, the following two approaches are recommended:

a) Apply a Bias and increase the base dose: Due to lateral development effects, achieving the target CD of the design might fall short, resulting in a slight deviation from the target CDs. This discrepancy is compensated by applying a bias, and slightly increasing the base dose which enhances the probability of clearing out the resist.
b) Change the correction model from 100% contrast to a 15% uniform clearing.

BEAMER simplifies the second alternative by providing the *Optimal Contrast/Uniform Clearing* option within the PEC Advanced settings (see Fig. 3).

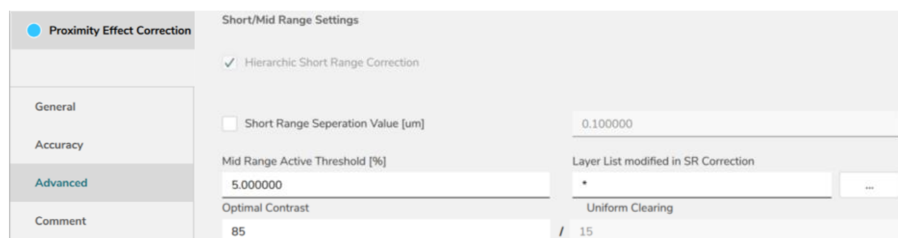

Figure 3. Advanced PEC settings showing the Optimal Contrast/Uniform Clearing option.

This option gives control over the dose applied to large areas such that they are always cleared without applying an external Bias to the layout. Usually, the *PEC* module will work together with a *3D E-Beam Edge* or *3D Laser Surface* module, such as these modules optimise their correction according to the contrast given in the *PEC* module (see Fig. 4).

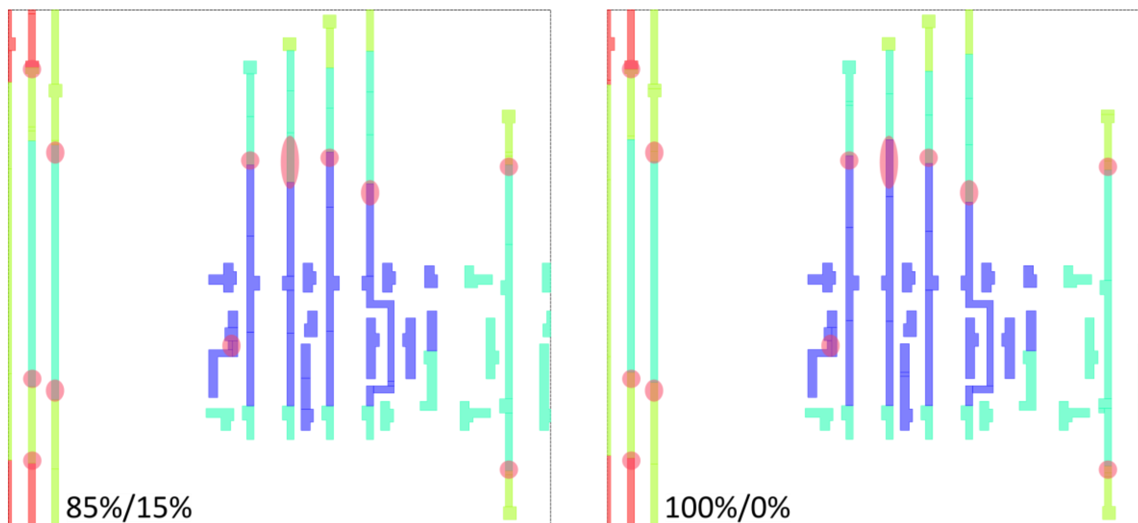

Figure 4. 3D Laser Surface corrections of a layout with PEC at different contrast/clearing ratios. (Left) 85% contrast and 15% clearing and (right) 100% contrast and 0% clearing. The red circles highlight some of the differences between both results.

While the above-mentioned methods offer solutions to resist residue issues, it is important to acknowledge the trade-offs involved. Although, adopting a lower contrast value and higher clearing can compromise contrast and increase sensitivity to process variations, however, the benefits of achieving uniform clearing and resist removal for certain device structures often outweigh these drawbacks, making these approaches valuable compromises.