Flare Variation Compensation for 32 nm Line and Space Pattern for Device manufacturing on EUVL

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EUVL is a promising technology for 32 nm half pitch node. Selete is installing a full-field exposure tool and has a mission to ensure availability of the high-volume manufacturing for the node devices. One of the key issues in achieving this is flare which degrades the critical dimension (CD) controllability on EUVL[1]. The intrinsic flare in the EUV tool is expected to be below 10%. But even at these flare levels, it is important to evaluate lithographic process window with flare variation correction (FVC) through the whole area varying 10% flare range in an exposure field. In this paper, we will describe a setting of optimum mask bias for FVC with practical lithographic process window and the possibility of precise FVC with 0 to 10% flare on a 32-nm line-and-space (L/S) pattern.

The lithographic performance was evaluated through aerial images with the commercially available TEMPESTpr™ simulator, which achieves a rigorous solution to Maxwell's equation using a finite-difference domain algorithm. The simulation exposure conditions were 0.25 for numerical aperture and 0.7 for illumination sigma at 13.5-nm wavelength.

As shown in figure 1, an edge placement of 4-nm on both sides of the mask pattern can compensate the effect of 10% flare on the L/S CD equal to 32-nm. Exposure latitude decreases as flare levels increase as shown in figure 2. At the maximum flare level, it was observed that the optimal exposure latitude can be obtained at a mask bias of -1.5nm. Given that a 4nm mask bias compensates for a flare range of 0-10%, an exposure latitude of over 23% can be achieved using mask bias from -1.5nm to -5.5nm to provide FVC. As shown in figure 3, mask enhancement error factor values were almost the same at around 0.8 against various flare variations. This means that the FVC values can be simply defined by understanding the flare levels. Lastly, as shown in figure 4, even with a mask grid size of 0.5-nm, which is viable in advanced e-beam tools, a residual error on FVC was below ±0.4 nm.

This confirms the practicality of applying FVC consisting of mask bias defined by flare values in achieving 32-nm L/S patterns of realistic exposure latitudes.

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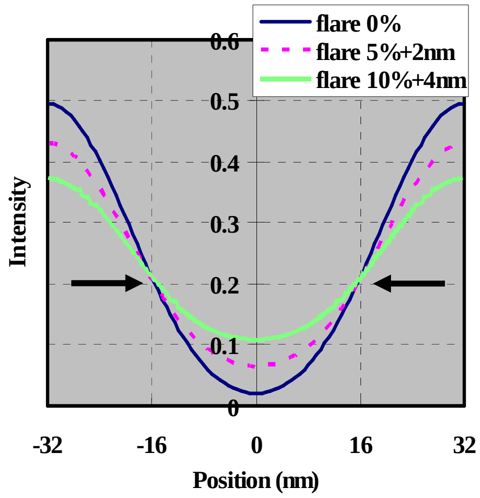
[1] M. Chandhok et al., Proc. SPIE 5374, 86 (2004)



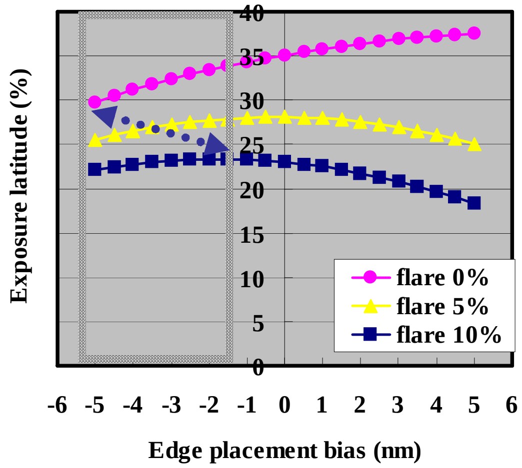


Figure 1. Simulated aerial images under CD equals to 32-nm-width with 0%, 5%, and 10% flare with 0 nm, +2 nm, +4nm mask bias respectively

Figure 2. Exposure latitude against flare variation with each mask bias compensation and drawing dot line area under optimum mask bias for 0 to 10% flare variation

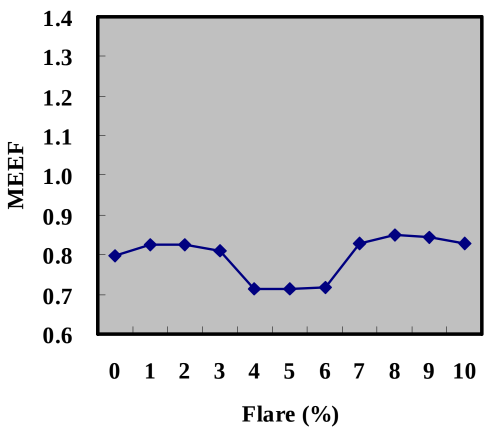


Figure 3. MEEF values under FVC with optimum mask bias

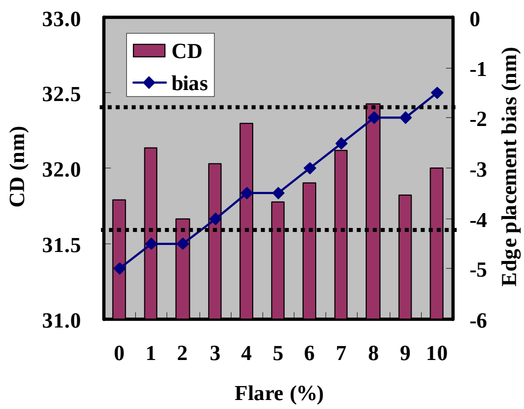


Figure 4. CDs compensated flare variation with 0.5-nm mask grid