**Introduction**

- Extreme Ultraviolet Lithography (EUVL) is a hot candidate for 22nm line and space (L/S) pattern. One of the critical issues in EUVL is flare, which is integrated light scattering from surface roughness in an optical system.
- Flare degrades the control of critical dimension (CD) uniformity across the exposure field. Also, it generates more CD sensitivity as L/S half pitch size decreases. Therefore it is more important to predict accurate flare map for flare compensation.
- The oblique illumination in EUVL system generates mask shadowing effect which affects flare.
- In this paper, the impacts of mask shadowing effect on flare in EUVL are investigated through flare map prepared by MATLAB simulation. Flare map is based on the pedestal model.

**Rule-based Flare Compensation Method**

- In rule-based flare compensation method, accurate calculation of flare map is important.
  
  **Rule-based Flare Compensation Method**
  
  I. Ideal mask pattern is defined.
  II. Flare level is calculated at all points within the mask through flare map using point spread function (PSF) of camera.
  III. Effect of flare level on CD is determined by experiments.
  IV. Finally, we bias mask features based on flare map and experimental data.
- Flare PSF of EUVL optics describes the response of EUVL imaging system to a point source. Also, we have approximated flare PSF to triple gaussian profile based on POB2 of the engineering test stand (ETS). Its intrinsic flare approximation is 16% including DC flare (4%) and local flare (12%).

**Flare Map Preparation**

- We have calculated flare level using Pedestal model. Once the flare PSF is determined, flare level depends on the absorber density of clear-field mask.
  
  **Pedestal model**
  
  \[ \text{Flare}(x,y) = T_{\text{mask}}(x,y) \otimes \text{PSF}(x,y) \]
  
  : Computationally, flare is defined as a convolution of the flare point spread function (PSF) with the clear-field mask. This definition of flare is called 'Pedestal model'.
- The exposure field size and resolution are properly set up by PC hardware capabilities, 1x1 mm² area and 40nm respectively.
- 3x3 mm² area should be considered to accurately calculate flare to the very edge of the 1x1 mm² area. The rest of 3x3 mm² is dark field filled with absorber.

**Flare Map for 40nm L/S Pattern**

- The exposure field consists of 25 patterned targets where 40nm L/S is patterned with 50% open ratio.
- 40nm L/S patterned target in the center of exposure field is focused on by flare map.
- Particularly, maximum flare level is located in the vertex of patterned target.
- Even in the 10x10μm² area, flare level variation is about 2%.

**Conclusion & Future Works**

- In this paper, we have investigated the impact of mask shadowing effect on flare in EUVL. We have shown that absorber thickness, off-axis angle and L/S half pitch size affect calculating flare level. Also, azimuthal angle affects on flare, but it is negligible.
- In spite of significant improvements in EUV optical fabrication technology, mask compensation will be required to reduce flare effect for CD uniformity. To compensate flare, we need more elaborate flare map and smaller flare bin at more advanced technology nodes in terms of increasing CD sensitivity.
- Consequently, in order to obtain more accurate flare level, flare should be calculated with considering EUVL mask topography and other conditions, such as material type, EUV reflectivity variation of thin absorber.