Simulations of patterned EUVL multilayer mask with embedded defects using rigorous coupled-wave analysis

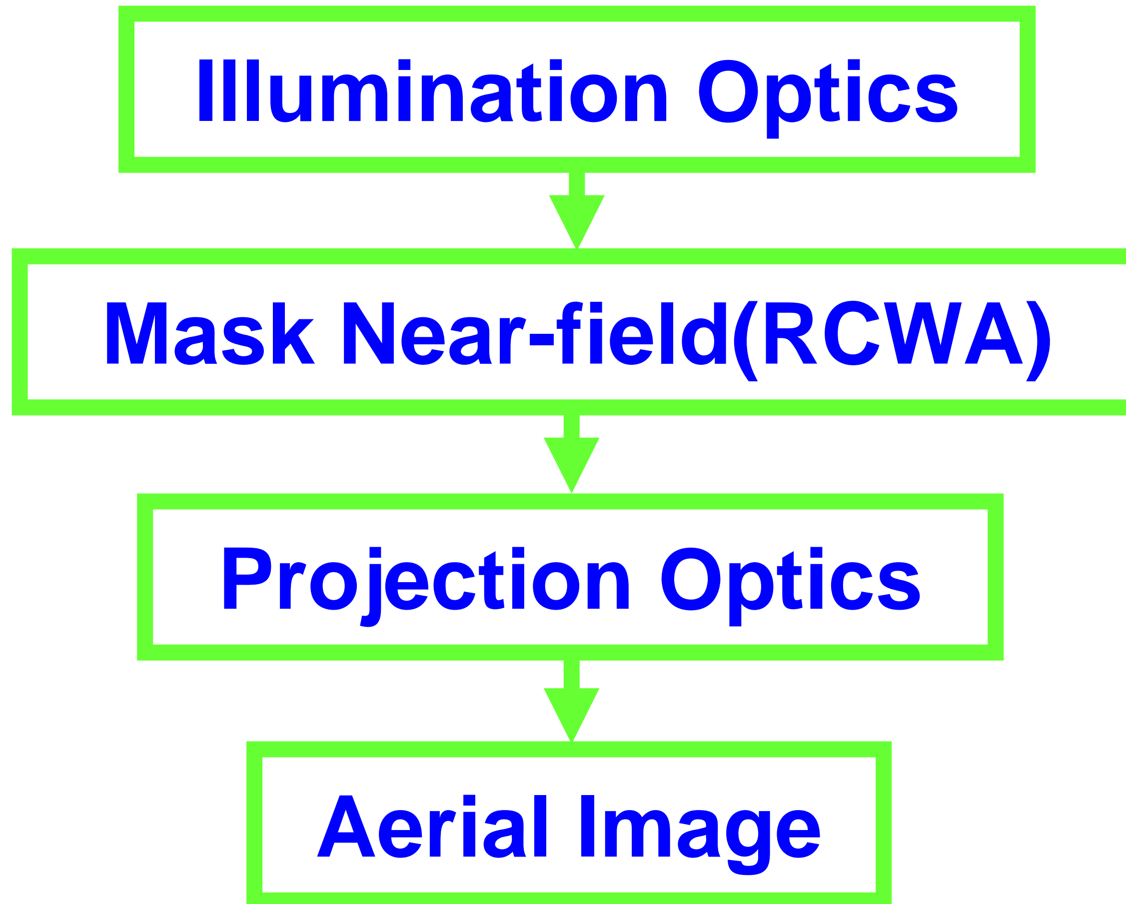
Seong-Sue Kim, Roman Chalyck, Sang-Gyun Woo,
Han-Ku Cho, Joo-Tae Moon, and Byung-Il Ryu

Semiconductor R&D Center, SAMSUNG ELECTRONICS

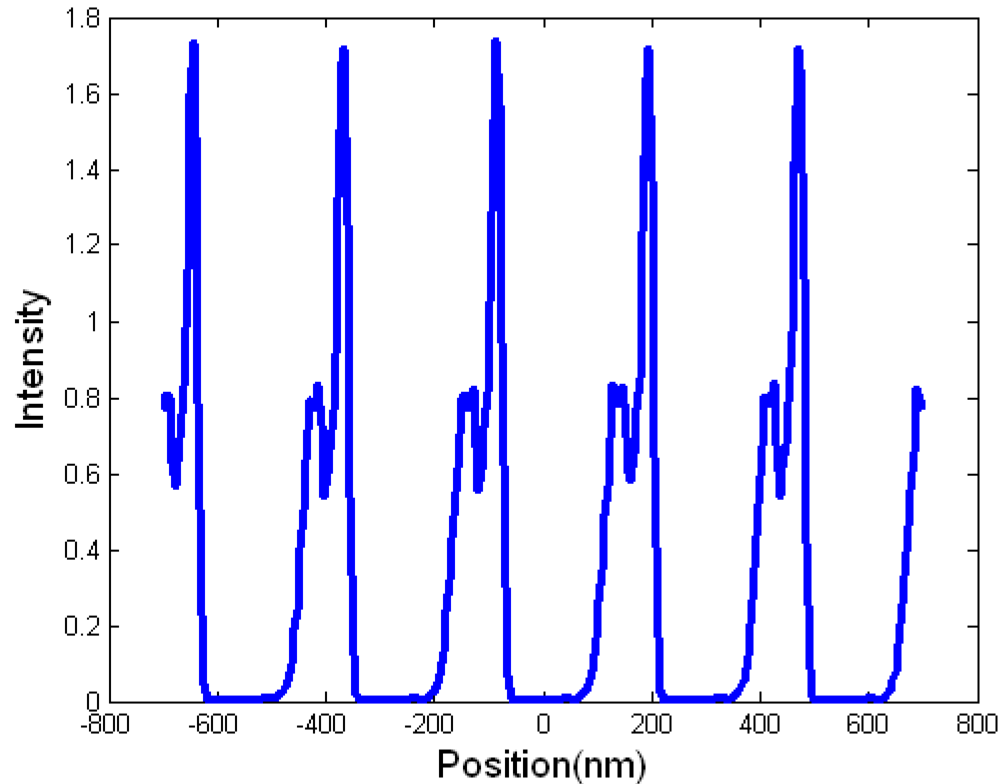
Contents

- Structure of EUVL Simulator
- Modeling of Phase Defect for RCWA Simulation
- Near-field and Aerial Image of Defective EUVL Mask
- ΔCD/CD *vs* Height of Defect
- ΔCD/CD *vs* Width of Defect
- ΔCD/CD *vs* Lateral Position of Defect
- Summary

Structure of Simulator



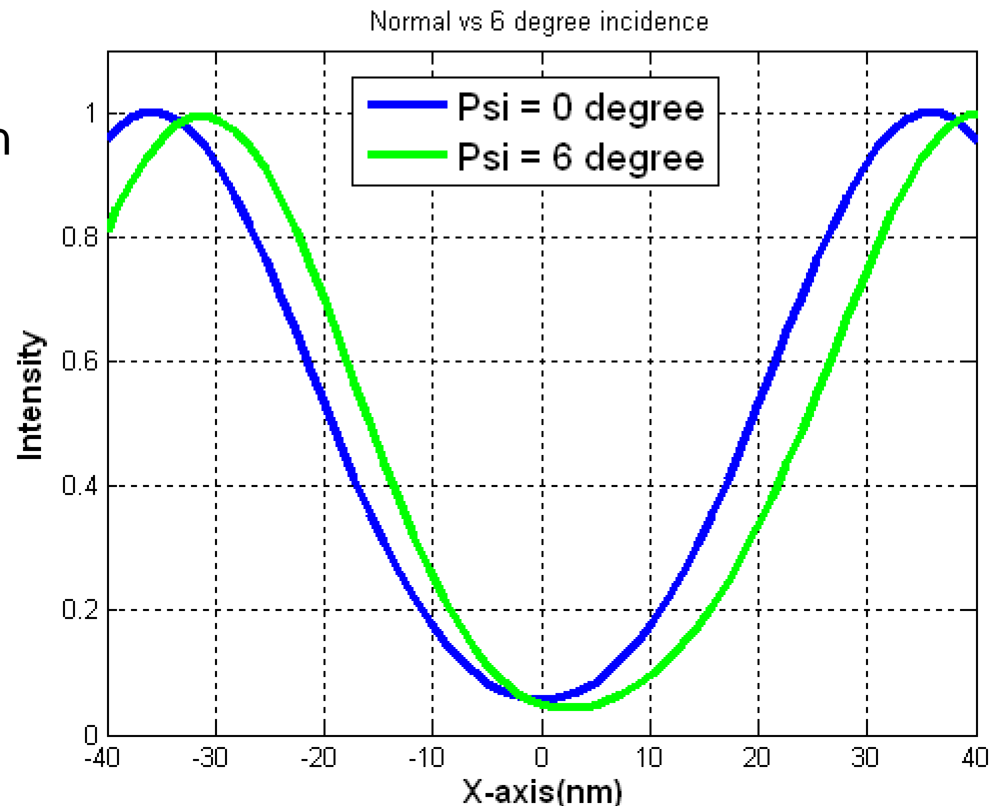
Intensity of Mask Near-field



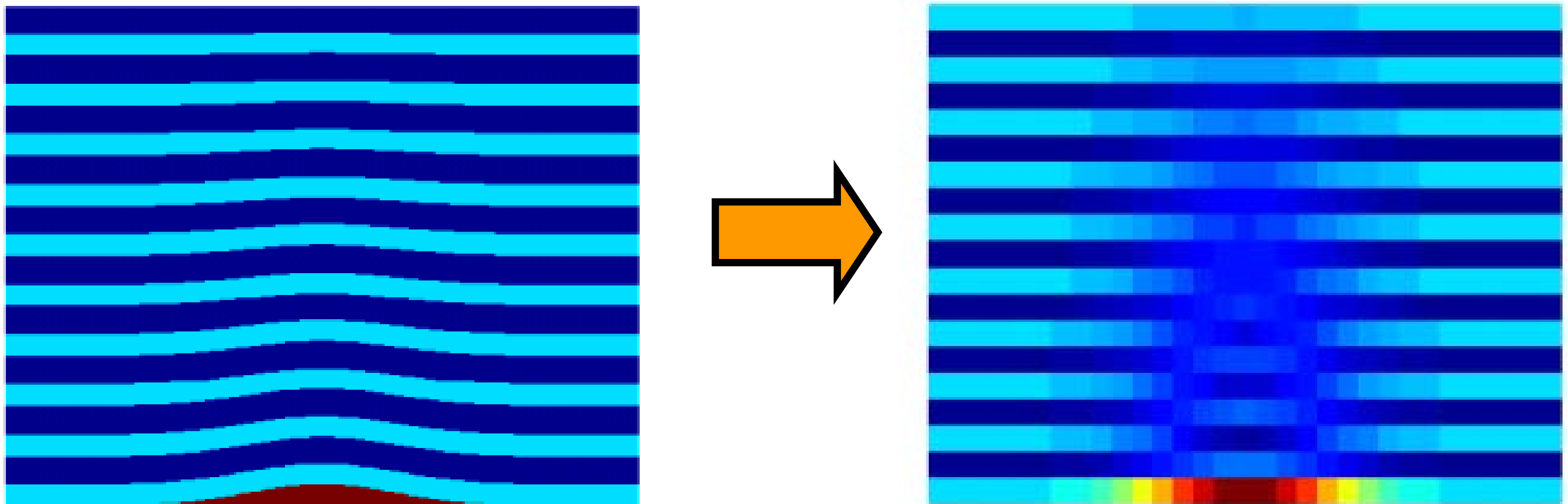
- Incidence Angle = 6°
- 32 nm 1:1 Line/Space Pattern

Aerial Image of EUVL Mask

- Incidence Angle = 6°
- 32 nm 1:1 Line/Space Pattern
- NA = 0.25
- Annular Illumination

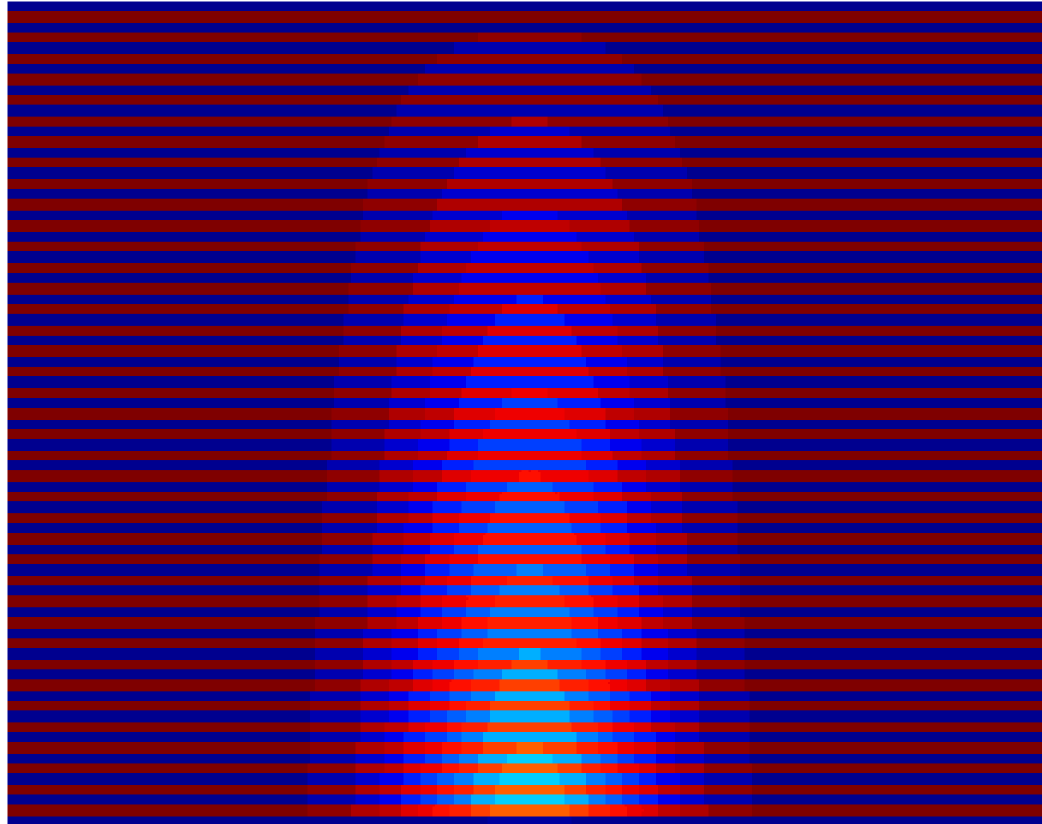


Modeling of Phase Defect for RCWA



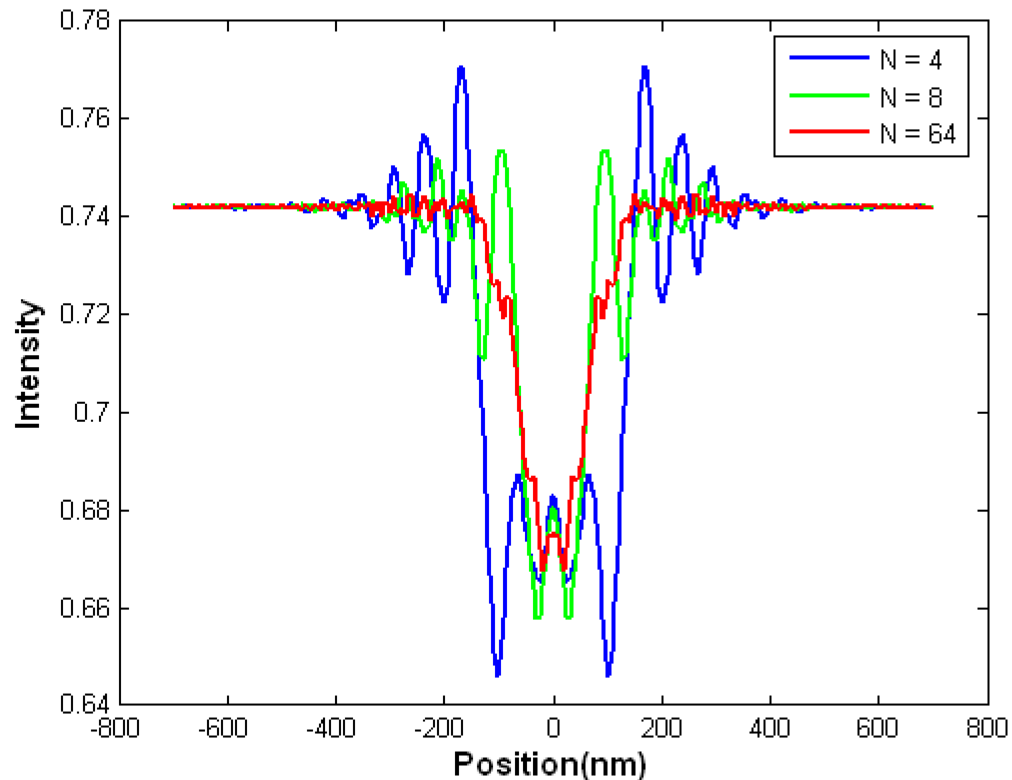
- Multilayer structure deformed by defect is decomposed into segments.
- Average dielectric constant is calculated for each segment.
- Deformed multilayer structure is converted into planar layered structure with inhomogeneous dielectric constants.
- Reflected field is computed by RCWA.

Mo/Si Multilayer with Phase Defect



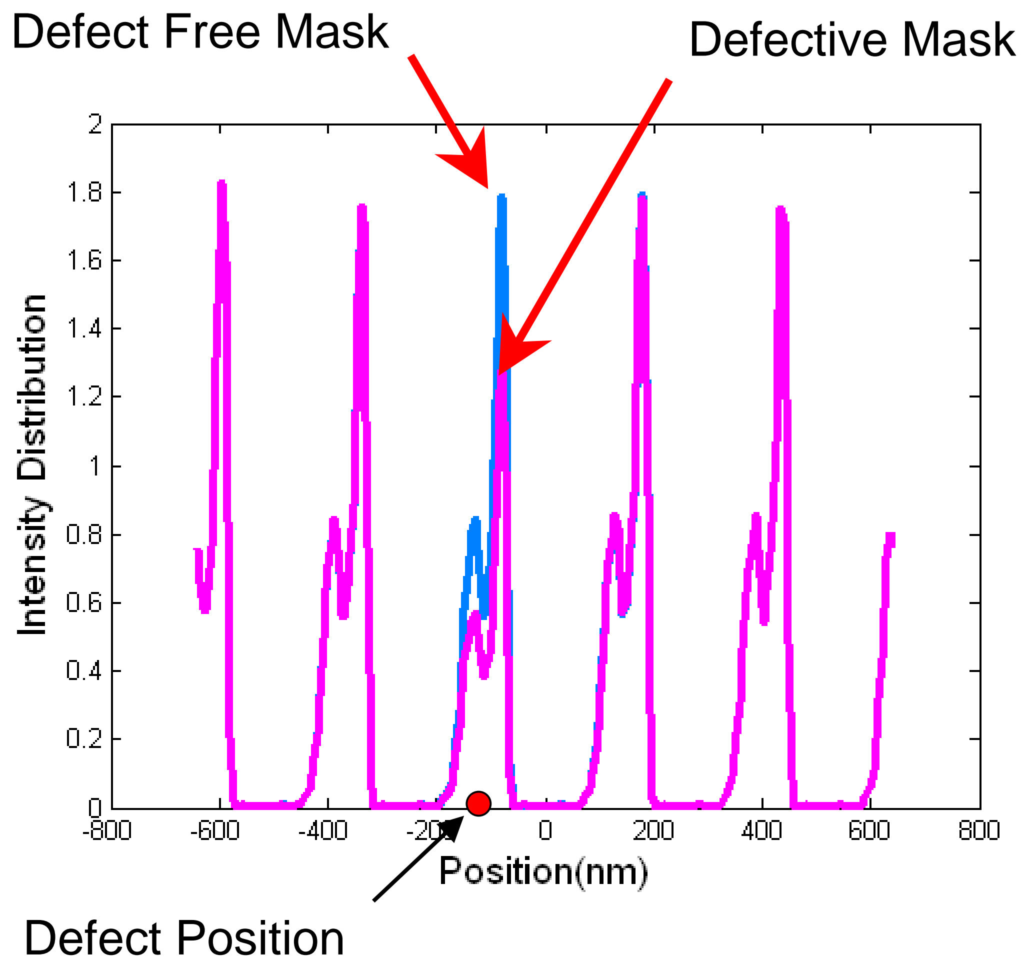
- 40-pair of Mo/Si Layers

Near-field of Phase Defect

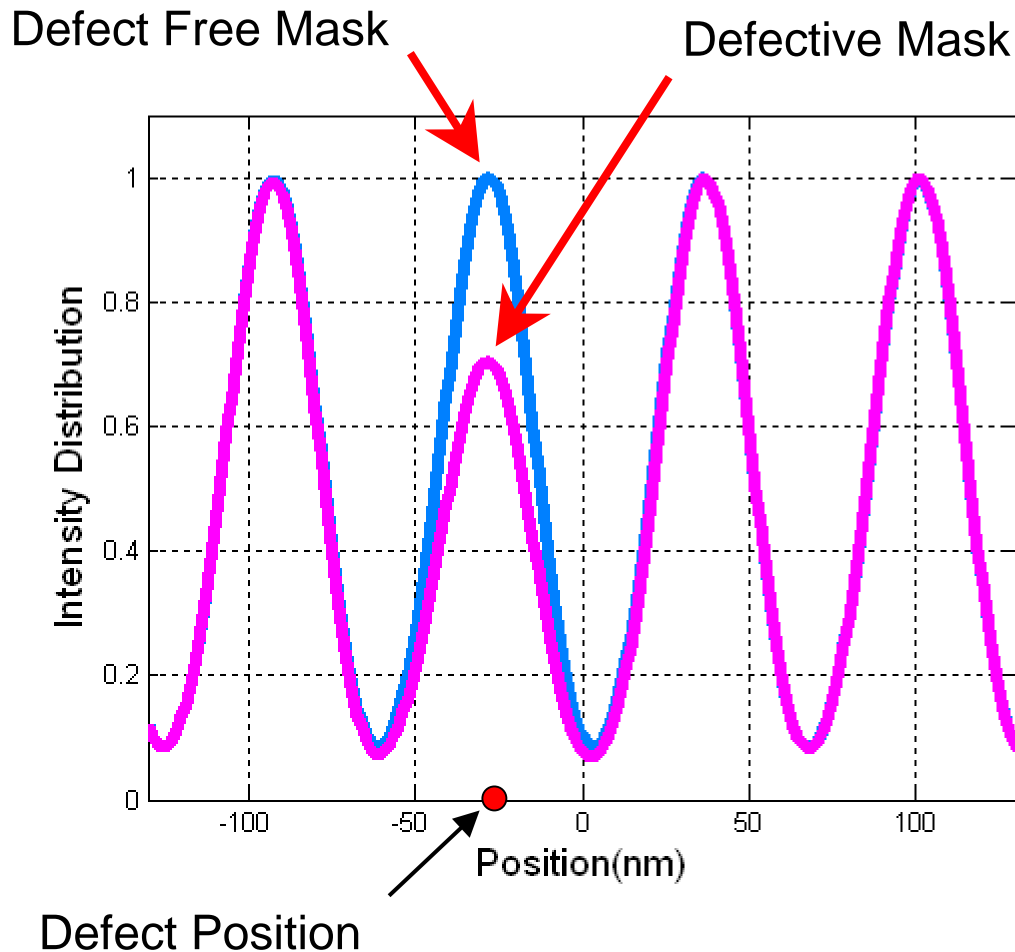


- Incidence Angle = 0°
- Height of Defect = 3 nm
- Width of Defect = 10 nm

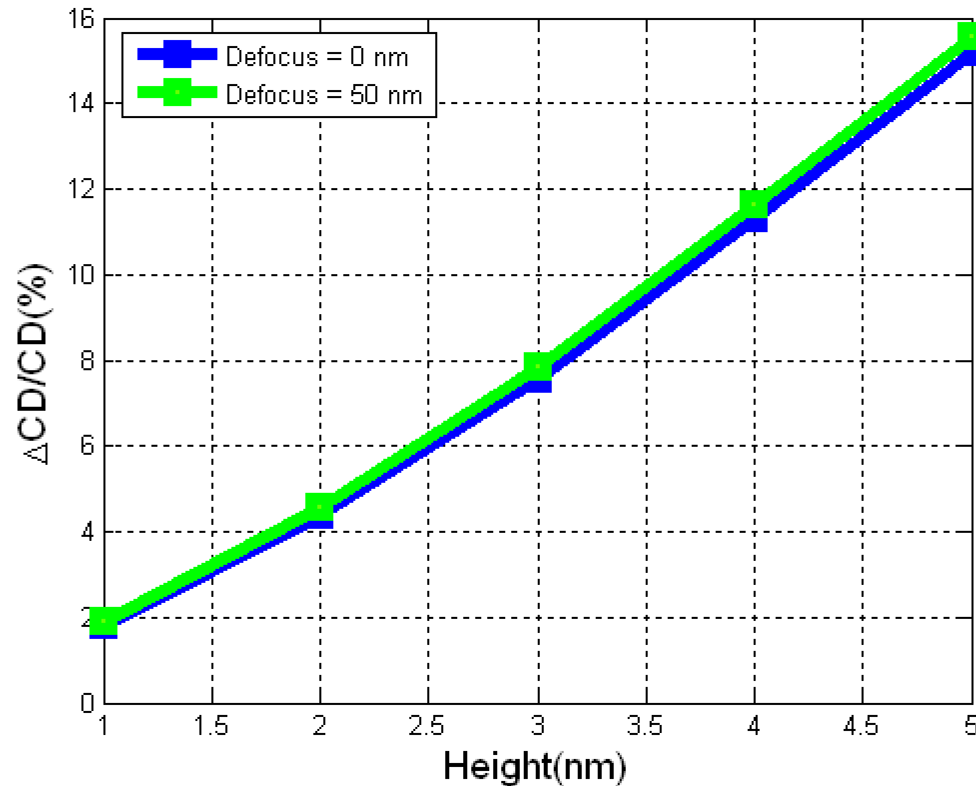
Near-field of Defective EUVL Mask



Aerial Image of Defective EUVL Mask



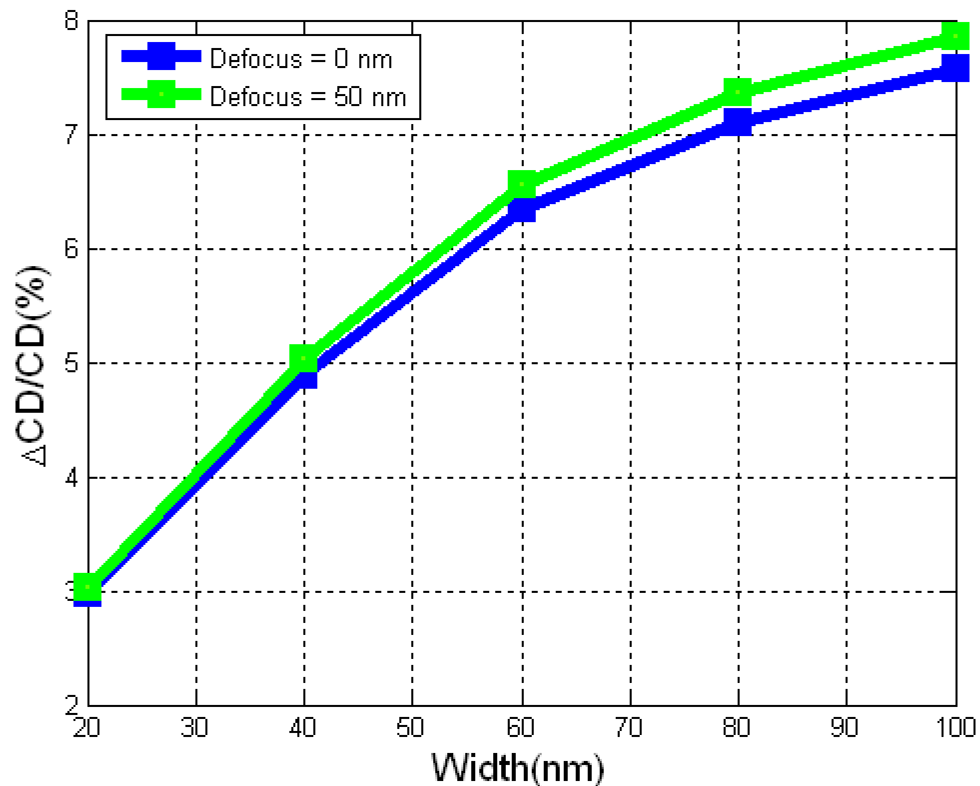
ΔCD/CD *vs* Defect Height



- CD increases linearly with defect height.

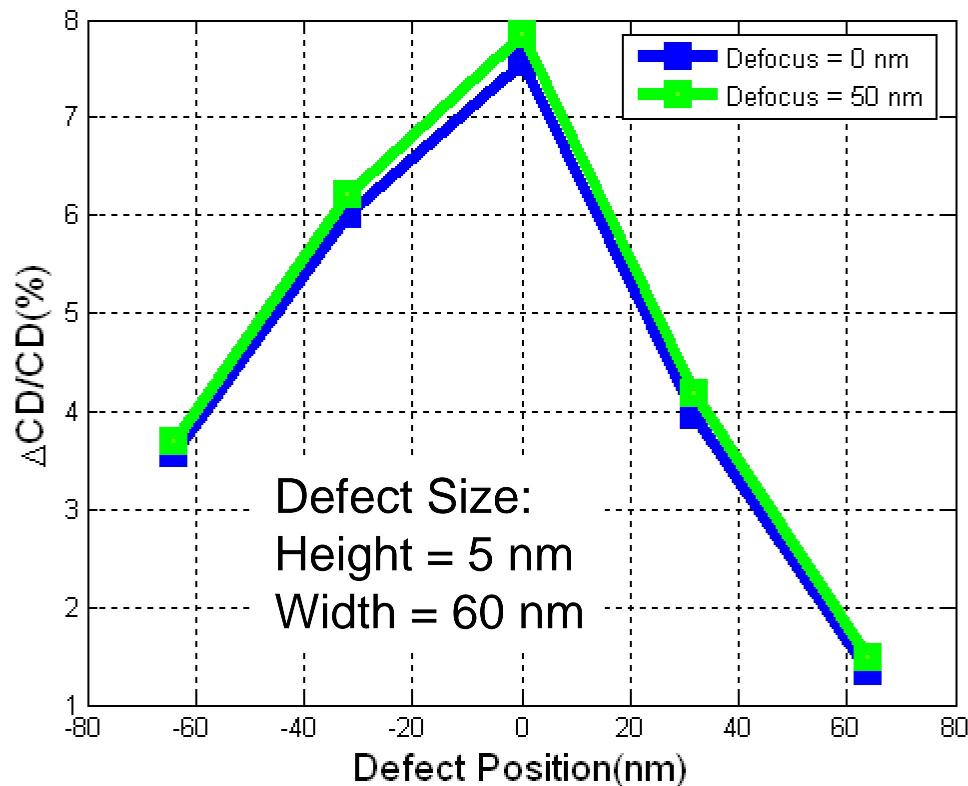
Samsung Memory
Spark of digital revolution

ΔCD/CD *vs* Defect Width



- CD increases with defect width but the rate decreases.

ΔCD/CD *vs* Defect Position in Lateral Direction



- CD variation is largest when the defect is located at the center of space.

Summary

- RCWA is applied to defect printability simulation.
- Mo/Si multilayer deformed by phase defect is modeled as a planar multilayer structure with inhomogeneous medium.
- CD increases with defect height.
- CD increases with defect width but the rate decreases.
- CD variation is largest when the defect is located at the ce nter of space.
- Defocus do not have significant effect on CD variation.
- To restrict CD variation within 5 %, the critical value of hei ght and width of phase defect is 2.2 nm and 40 nm, respec tively.