Characteristics of TaGeN films for EUVL mask absorber

1. Background
2. EUV absorbance
3. Dry etching properties
4. Conclusions

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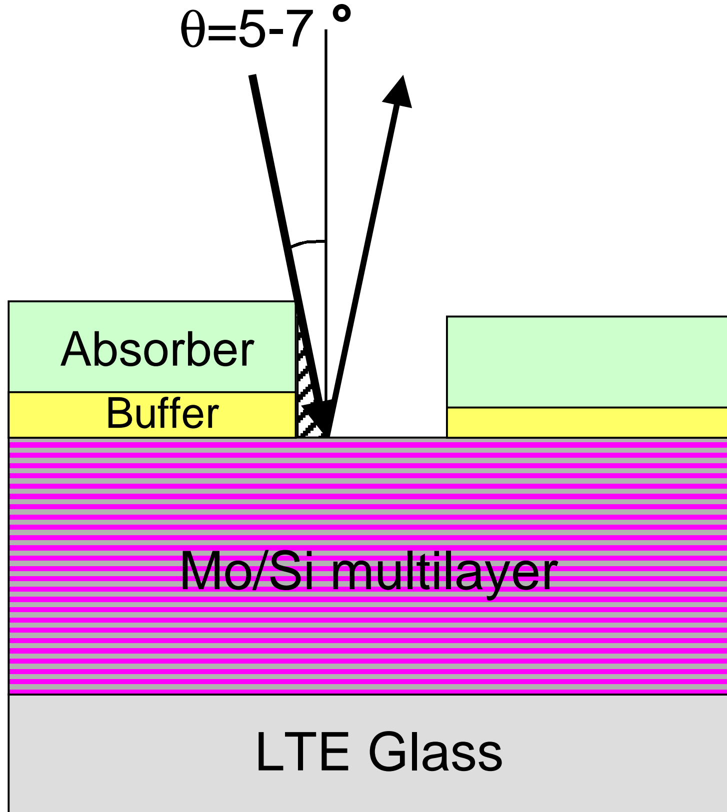
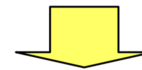
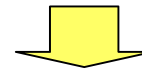
Background (1)



- EUV light incidents on EUVL masks obliquely.
- Precise CD control is required for 45-nm node EUVL masks.

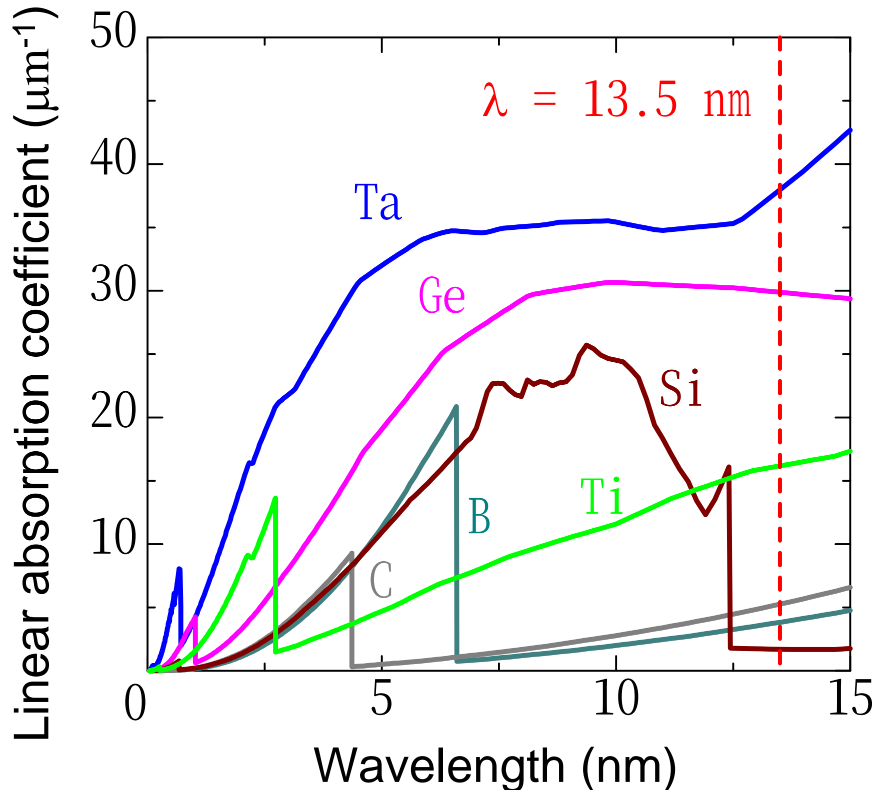


If the absorber film is thick,
shadowing effects produce CD shifts and absorber etching becomes difficult.



High absorbance material is desirable for EUVL mask absorber.

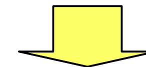
Background (2)



Linear absorption coefficients of several elements which are popular to make Ta-based amorphous absorber.

Amorphous material is desirable for EUVL mask absorber because of high stress stability, precise CD control and small LER.

Linear absorption coefficient of the Germanium is relatively large at 13.5 nm.



We thought the TaGeN was one of the promising candidates for high absorbance amorphous absorber.

Experimental Condition (1)

<Purpose>

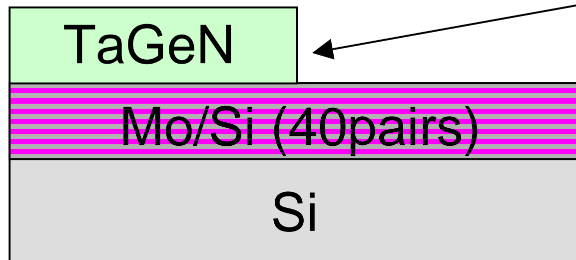
Evaluate the absorption coefficient of TaGeN films.

<TaGeN deposition>

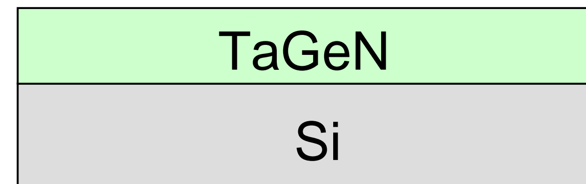
Method: DC magnetron sputtering
Target: TaGe
Gas: Ar+N_2

<Sample structure>

deposit continuously



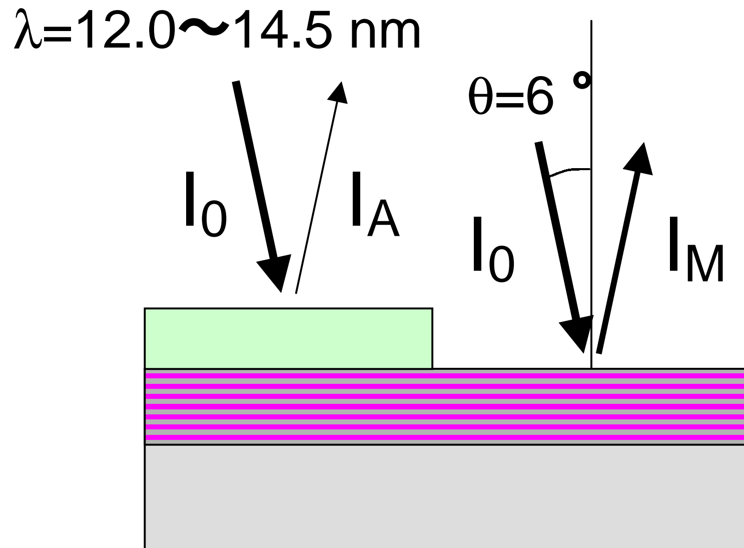
for the measurement of mask contrast



for the measurement of film thickness

EUVL ASET

Mask Contrast Measurement Method



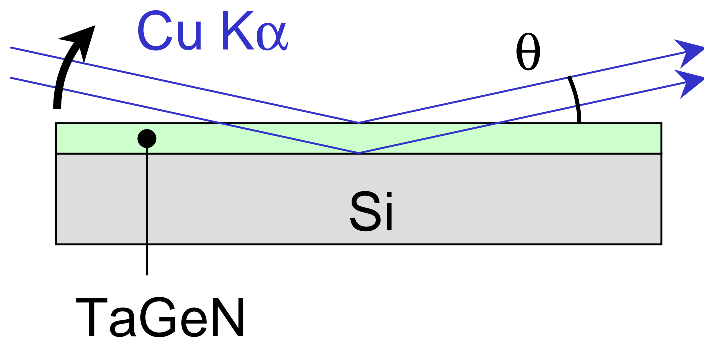
The EUV reflectometer at ASET Atsugi Site.

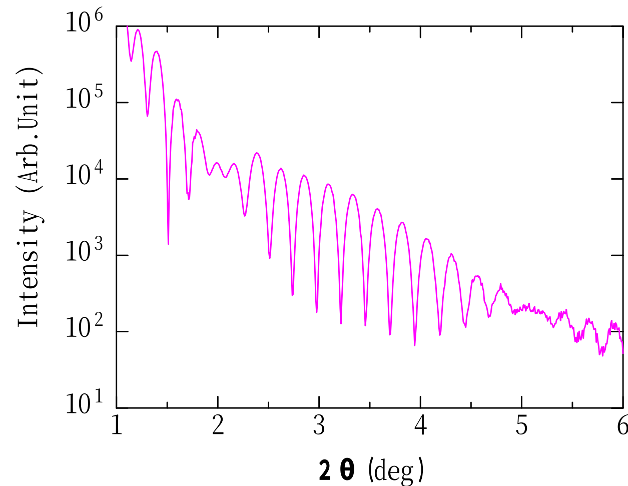
$$\text{Mask Contrast (M.C.)} = \frac{I_M/I_0}{I_A/I_0}$$

(@Centroid wavelength±0.1 nm)

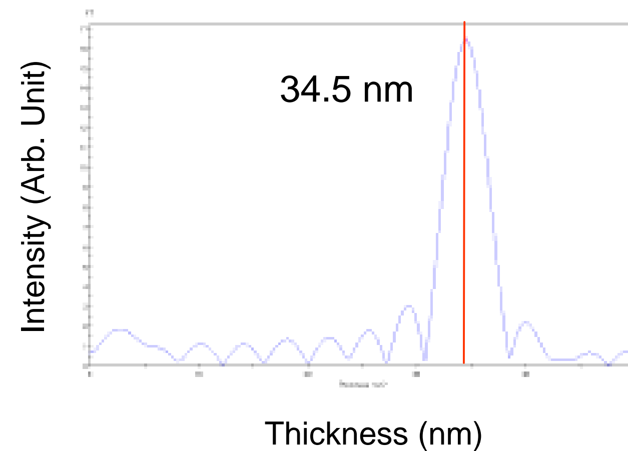
Mask contrast was measured by using an EUV reflectometer.

Absorber Thickness Measurement Method





Raw data

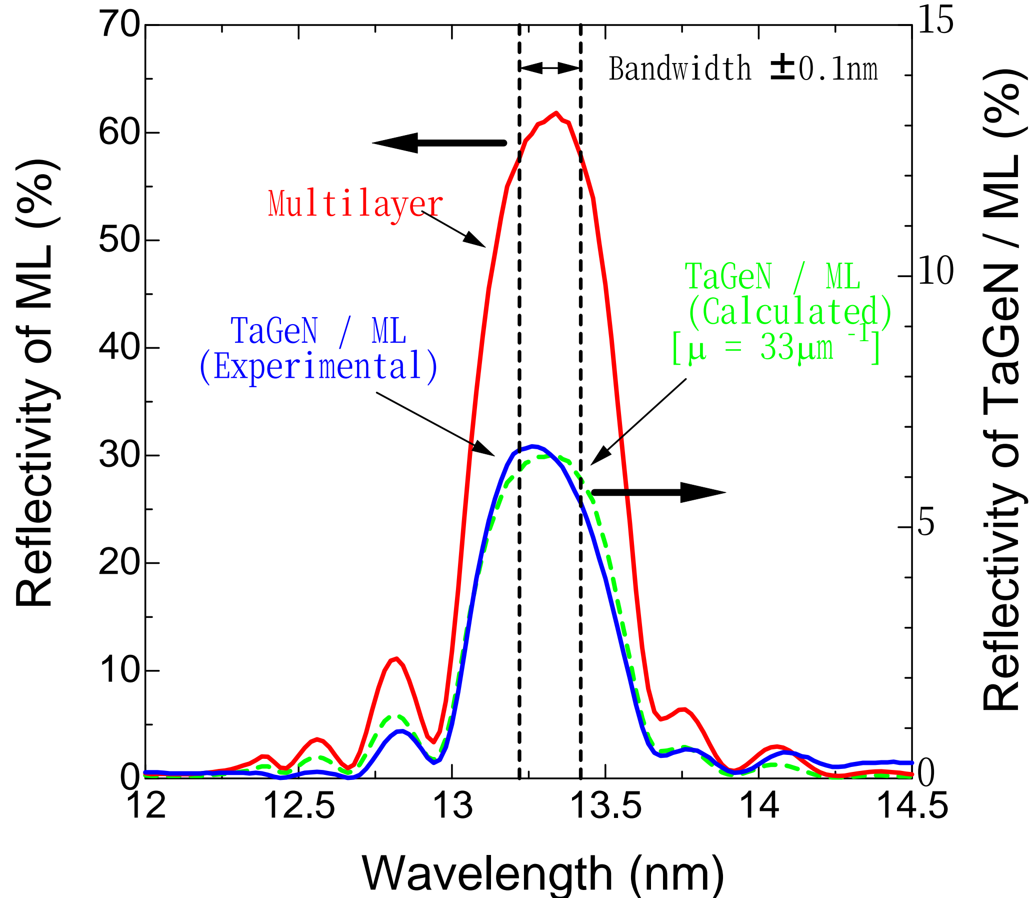


Thickness (nm)

Analyzed data

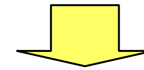
Absorber thickness was measured by using an x-ray reflectometer.

Reflectivity of TaGeN(34.5 nm)/ML



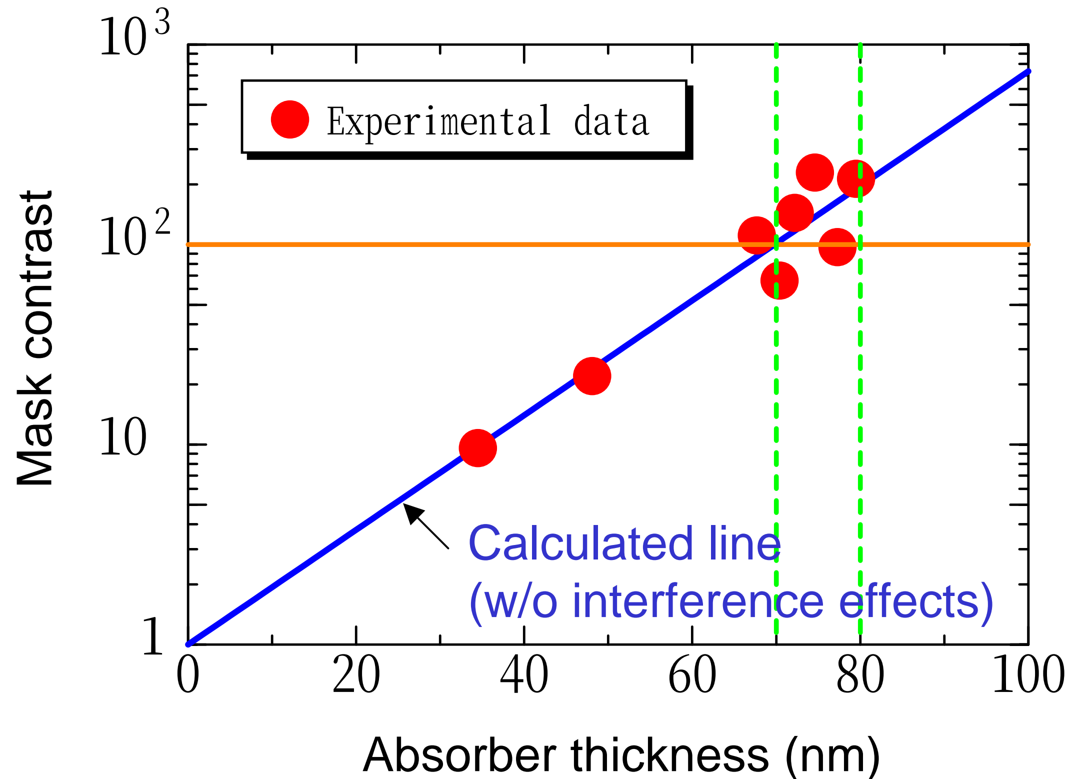
Measured M.C.: 9.6

Thickness: 34.5 nm



From these data, the absorption coefficient of TaGeN is estimated to be 33 (μm^{-1}) [λ=13.5 nm].

Mask Contrast vs Absorber Thickness



The required TaGeN thickness to obtain the mask contrast of 100 is 70 nm without considering the interference effects and 80 nm with considering that effects.

Experimental Condition (2)

<Purpose>

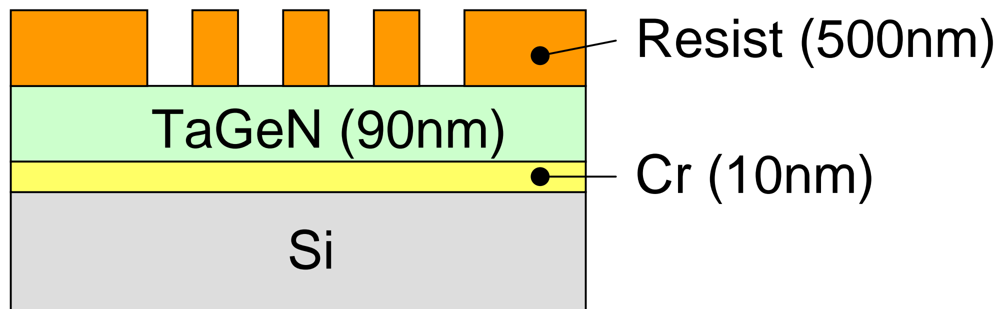
Evaluate the dry etching properties of TaGeN films.

<TaGeN Etching>

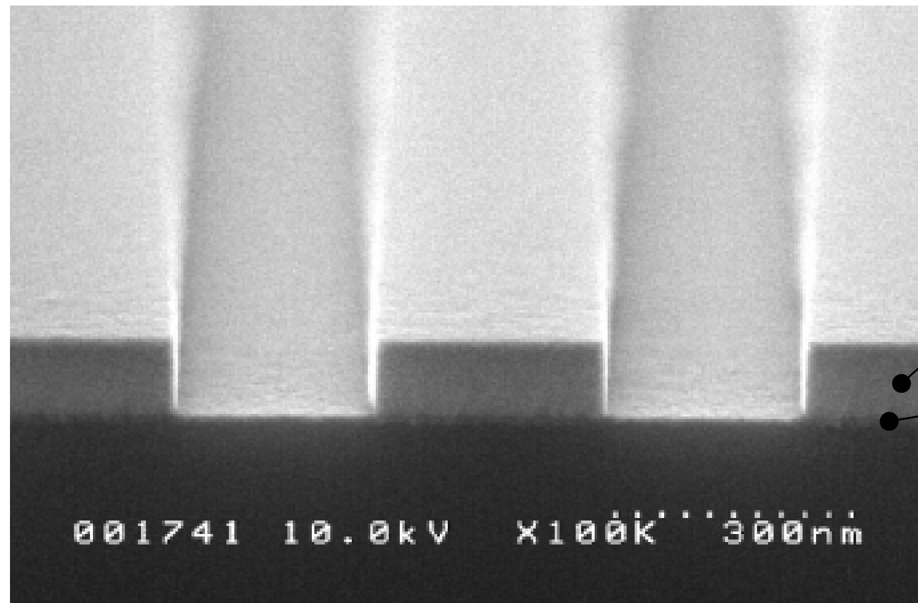
Method: ECR plasma etching

Gas: Cl_2

<Sample Structure>



Etched Pattern Profile



TaGeN (90 nm)

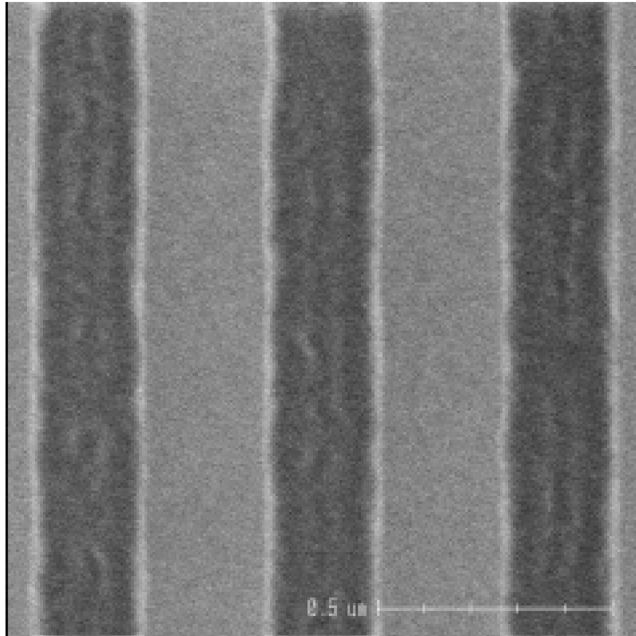
Cr (10 nm)

275-nm L/S TaGeN patterns

Selectivity to resist 1.0

Selectivity to Cr buffer 20

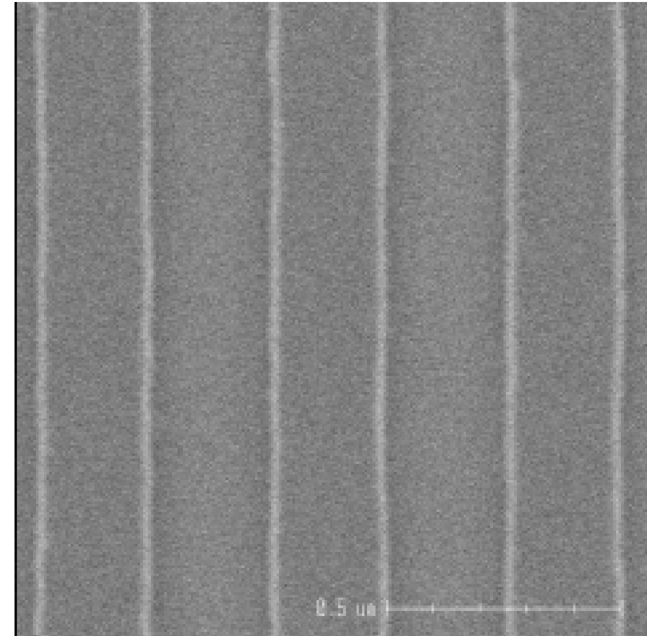
CD Control and LER of the TaGeN Patterns



(1) Resist Pattern

Line width = 257 nm

LER = 7.5 nm (3σ)



(2) TaGeN Pattern

Line width = 252 nm

LER = 5.8 nm (3σ)

Designed width = 250 nm

Conclusions

- The absorption coefficient of the TaGeN was estimated to be 33 μm^{-1} (@ λ=13.5 nm) .
- The required TaGeN thickness to obtain the mask contrast of 100 is 70 nm without considering the interference effects and 80 nm with considering that effects.
- The etching selectivity of TaGeN/Resist was about 1.0 and that of TaGeN/Cr was about 20.
- 275-nm L/S TaGeN patterns were successfully fabricated.
- There was no serious problem in CD control and LER of TaGeN patterns.

Acknowledgement

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