Variability of the EUV etch process

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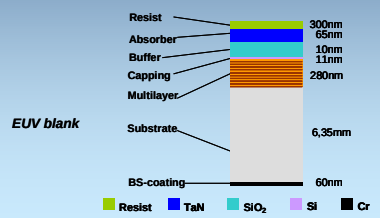
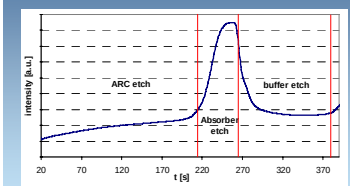
Introduction

- Standard absorber (Cr) well known etch process variability → Only limited manipulation of final performance possible, strong linkage of parameters.
- EUV with TaN absorber was investigated with respect to time, plasma power, pressure, etch gas composition, coil ratio to find optimum process conditions.

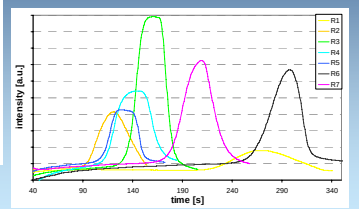


Endpoint detection

- The endpoint detection provides information about the etch rate of the ARC and TaN absorber as well as rough estimate of depth uniformity.



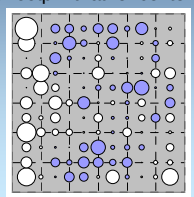
OES -EP detection for ARC, absorber and buffer



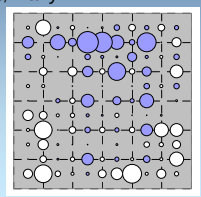
Variation of etch rates and ARC depth uniformity during absorber etch process

CDU footprint of absorber etch

- CDU variability of the absorber etch process rather limited.
- Very weak dependence on etch process conditions.
- With current material CDU can be optimized as low as 3 nm at uniformly loaded mask design and 132x132 mm^2 area.
- CDU footprint rather center fast, if any.



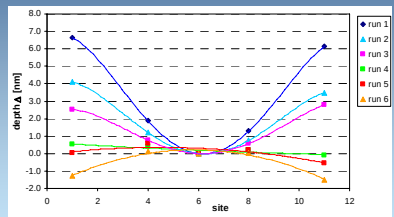
Absorber etch
Best CDU ~ 3.5-4 nm 3σ

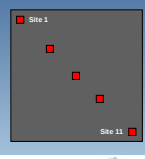


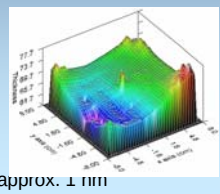
Absorber etch
worst CDU ~ 5-6 nm 3σ

Absorber etch depth uniformity

- Depth footprint of the absorber etch can be flipped from center slow to center fast



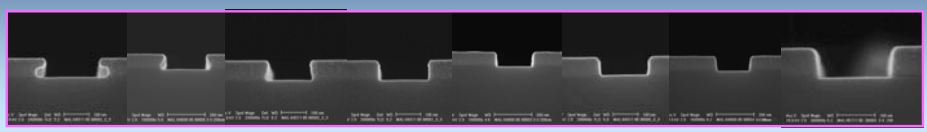




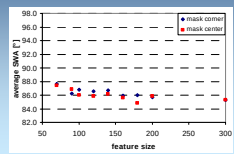
- The factor for depth uniformity identified and can be controlled within the precision of the depth measurement (~ ±0.5nm)
- Slight linear effect observed with depth difference approx. 1 nm

Side wall slope variation

- Side wall shape can be varied in broad range of angles: strong underetch with T-topping due to ARC layer – side wall slope of about 80 °
- The side wall angle is at some conditions feature size dependent.



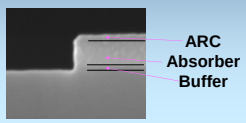
SWA variation at different process parameters



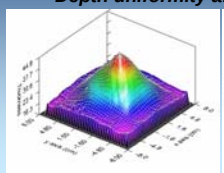
SWA as function of feature size

Buffer etch

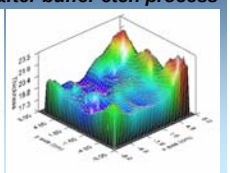
- Wet buffer etch of SiO_2
- Buffer etch process shows high selectivity to underlying capping layer
- No underetch can be observed



Depth uniformity after buffer etch process



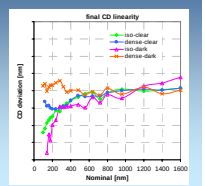
Initial wet etch process



Modified etch process

CD linearity

- final CD linearity mainly given by resist linearity
- minor variation due to etch process



Conclusions

- The key parameter influencing the EUV absorber etch process and buffer etch process were identified
- TaN Process very flexible – optimum for SWA, depth profile, CDU etc. can be tuned independently of each other
- CDU rather stable at lower 3σ values
- SWA is process and slightly feature size dependent

Acknowledgements

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