NOLOSS
Lossless photon management
Optical design for manufacture at different length scales

Marie Curie Actions

TU Delft ASML

EUV Mask Metrology via Ptychography

P. Ansuinelli, W.M.J. Coene, H.P. Urbach
TU Delft, ASML - Netherlands
p.ansuinelli@tudelft.nl wim.coene@asml.com H.P.Urbach@tudelft.nl

Project objective

The successful implementation of extreme ultraviolet lithography (EUVL) for the next-generation technology nodes depends critically on the availability of EUV mask technology and related actinic (@13.5 nm) mask metrology.
In particular, we are investigating sub-wavelength resolution using model based estimates of parametrized a-periodic features which are of interest owing to current trends in the lithography industry.

Motivation

Metrology of 3D EUV masks is important for:

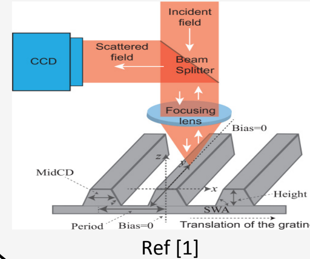
- Detection of mask defects in the patterned absorber
- Control proper absorber patterning

Patterned absorber image courtesy of ASML

Scatterometry and Ptychography

Far-field diffraction-based metrology will be employed. We will complement the technique of X-ray ptychography making use of prior information about the target, given by the lithographic mask, to extend metrology to a-periodic samples..

Optical Scatterometry



Ref [1]

Soft X-Ray Ptychography

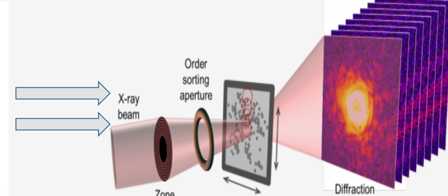


Image : Stanford Synchrotron radiation lightsource

Materials

The absorber pattern lays upon a Si/MoSi2/Mo/MoSi2 multilayer that enables reflection of EUV light.

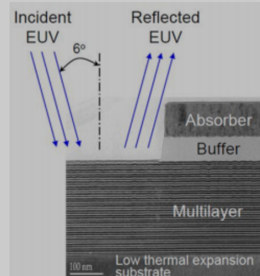


Image: “Overview of EUV Mask Metrology”- SEMATECH Inc.

Stack (Bottom to Top):

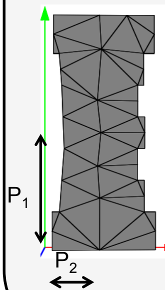
Material	n	k	Thickness
Ru	0.88586	0.01727	0.5 nm
TaBN	0.95	0.031	58 nm
TaBO	0.952	0.026	2 nm

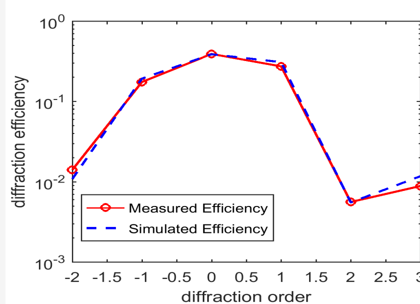
Multilayer:

Material	n	k	Thickness
Si	0.99888	0.00183	1.8968 nm
MoSi2	0.96908	0.00435	0.7986 nm
Mo	0.92347	0.00649	2.496 nm
MoSi2	0.96908	0.00435	0.7986 nm

Numerical results

We consider as a first test case a mask with periodic 3D absorber profile as shown.





$$\chi^2 = \sum_{n=1}^{N}\sum_{j=1}^{M}\left(\frac{I_{nj}^{meas} - I_{nj}^{sim}}{I_{nj}^{meas}}\right)^2$$

Parameter	Nominal Value [nm]	Reconstructed Value [nm]	σ [nm]
P_1	-42.5	-41.2	1.21
P_2	-13.38	-12.85	0.45

References

[1] N.Kumar, P. Petrik, G.K.P. Ramanandan, O. El Gawhary, S. Roy, S. F. Pereira, W. M. J. Coene and H. P. Urbach, Opt. Express Vol. 22, pp. 24678-24688 (2014)
[2] J. M. Rodenburg and H. M. L. Faulkner, Appl. Phy. Lett., 85:4795–4797, (2004)

This research has received funding from the European Union’s Horizon 2020 research and innovation program under the Marie Skłodowska-Curie Grant Agreement No. 675745.