EUV resist process development for full field imaging

Ardavan Niroomand [2], Anne-Marie Goethals [1], Frieda Van Roey [1], Byeong Soo Kim [3], Gian Francesco Lorusso [1], Ivan Pollentier [1], Rik Jonckheere [1] and Kurt Ronse [1]

1) IMEC, 2) on assignment from Micron Technology, 3) on assignment from Samsung Electronics

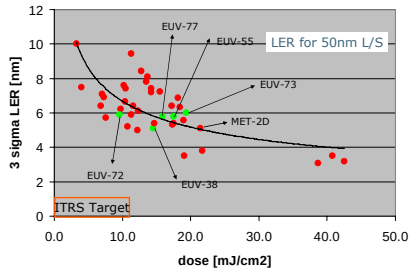
Abstract

A major challenge for EUV resists is to simultaneously achieve resolution, sensitivity and line edge roughness requirements for the 32nm HP. Using EUV interference lithography, these 3 parameters have been extensively tested for many resist materials and chemistries from commercial suppliers. Good progress in resist performance has been realized as a resolution of 25nm HP and photospeed of around 10mJ/cm² and below has been demonstrated with some of the materials.

As part of process development toward integration into device manufacturing process, compatibility of EUV resist with two different BARC was investigated.

Finally, as the ASML's Alpha Demo Tool (ADT) became available for imaging, initial imaging results with MET-2D are presented.

EUV resist screening in interference lithography (PSI)

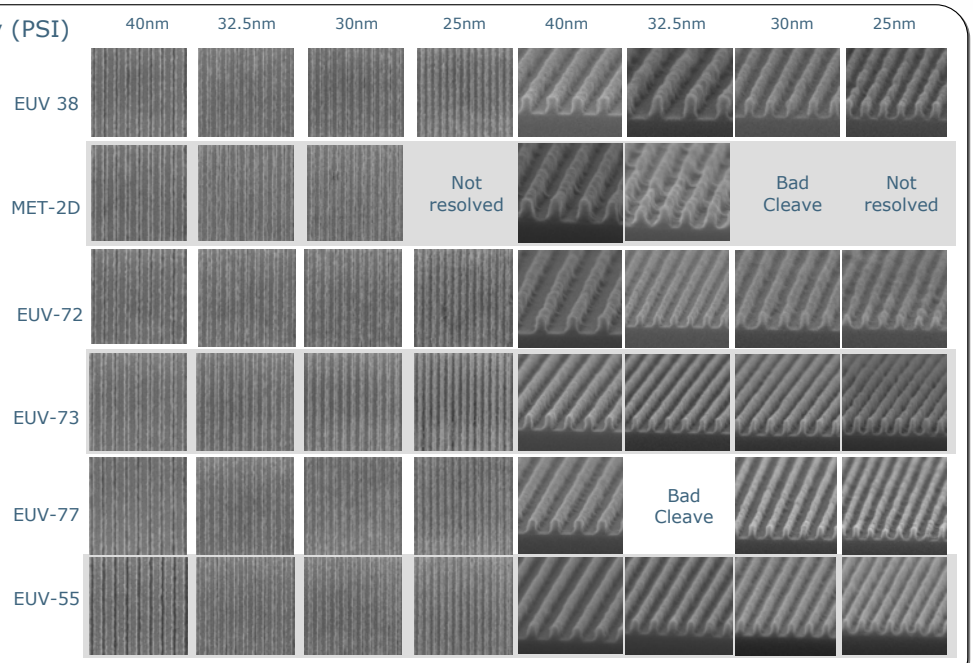


Resist	Dose for 50nm L/S (mJ/cm2)	LER 3 sigma (nm)	EL %	Resolution nm	Failure Mechanism
EUV-38 **	14.8	5.1	26	25	Bridging
MET2D *	22.8	5.4	14	32.5	Bridging, Residuals
EUV-71	6.6	6.4	14	45	Pattern Collapse, Bridging
EUV-72 ***	9.8	5.6	27	25-30	Top loss
EUV-73	19	6.1	20	25-30	Pattern Collapse
EUV-77	15.5	5.8	35	25-30	Pattern Collapse
EUV-55	17.5	5.8	19	25	Bridging

* MET-2D is the ASML's approved imaging resist for ADT

** EUV-38 is the current best resist resist, based on overall performance in previous screening

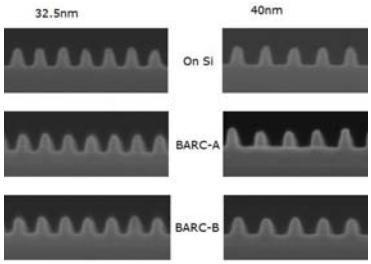
*** EUV-72 showed best overall performance in most recent screening

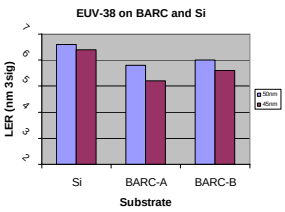


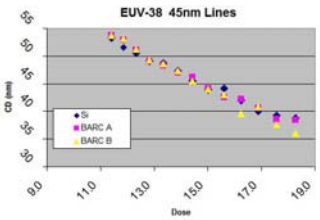
SEM Micrograph of some resist samples with 25nm resolution, and MET-2D

Compatibility of EUV resist with BARC

EUV-38 Resist		On Si	On BARC (A)	On BARC (B)
50nm	E_{CD} (mJ/cm2)	13.7	13.7	13.5
	EL (%)	31.4	28.7	31.7
	LER (3sig. nm)	6.6	5.8	6.0
45nm	E_{CD} (mJ/cm2)	14.9	14.7	14.6
	EL (%)	28.7	22.1	20.8
	LER (3sig. nm)	6.4	5.2	5.6
40nm	E_{CD} (mJ/cm2)	16.2	17.0	16.7
	EL (%)	24	26	21

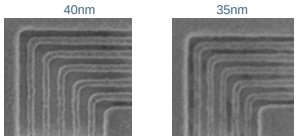




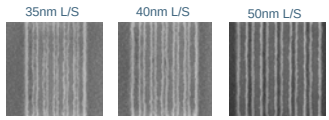


First images from ADT tool with Sn Source at IMEC

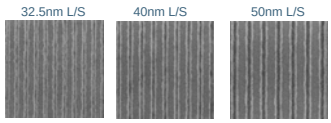
40 and 35nm features were exposed on IMEC's ADT with Sn source, using MET-2D resist, and compared to exposures with interference lithography. It must be noted that the ADT images were obtained before the completion of final lens tuning on the tool.



Shadowing effects in the L-Bars seen in ADT exposure

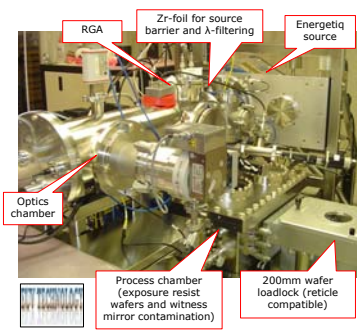


Vertical lines/spaces on ADT using MET-2D (dose ~18mJ/cm²)



Comparison to line/spaces using MET-2D obtained by interference lithography (PSI)

EUV resist outgassing set-up

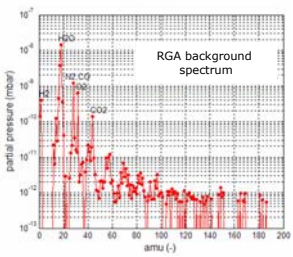


Application

-Controlled contamination of witness mirror by EUV resist exposure for reflectivity measurements

-RGA analysis of outgassed (resist) species

-Controlled reticle contamination



Summary and Conclusions

•Initial imaging results from ASML ADT tool with Sn Source are presented with MET-2D resist.

•A large number of advanced resist samples are screened on PSI tool and there has been a steady progress in resist performance with respect to photo speed, roughness and resolution. Several resists are achieving 25nm resolution.

•EUV-38 is shown to be compatible with 2 different BARCs; use of BARC results in reduced LER.

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