



ITRS roadmap Update for EUV Masks

October 2009





Team Formation

- A team was formed in May, 2009 to update ITRS EUV Mask Specific Parameters
- Team Objective
 - Provide a more systematic inputs by subject matter experts on EUV specific mask requirements
 - Establish stronger reasoning behind line item roadmap
- Roles and Responsibilities
 - Provide individual inputs to roadmap
 - Provide additional inputs or “justifications” if initial inputs are significant different than group
 - Participate in open forum roll up meeting
- Confidentiality
 - ITRS is a public document
 - Individual inputs are sought after
 - SEMATECH rolls up inputs as GENERIC results



Team Members

Scanner Companies	ASML	John Zimmerman
	Canon	Miyake Akira
	Nikon	Tsuneyuki Hagiwara
Consortium	SELETE	Kazuya Ota
	SELETE	Tsuneo Terasawa
	IMEC	Rik Jonckheere
	SEMATECH	David Chan
	SEMATECH	Greg Hughes
	SEMATECH	Abbas Rastagar
Users	Intel	Ted Liang
	Samsung	Seongsue Kim
	Global Foundries	Bruno La Fontaine
	UMC	George Huang
	Toshiba	Hiroyuki Mizuno
	Hynix	Changmoon Lim
University / Nat. Lab	LBLL	Patrick Naulleau
Material Suppliers	AGC	Yoshiaki Ikuta
	Hoya	Tsutomu Shoki
Mask Shops	DNP	Naoya Hayashi
	Toppan	Craig West
	AMTC	Karten Bubke



#	Parameters	Conclusions from Taskforce
1	Mask Magnification	No change
2	Nominal Image Size	No change
3	Minimum Primary Size	No change in numbers. Change color white to 99nm, yellow to 70nm, and red below 70nm. Get optical mask team to agree.
4	Image Placement	Change maximum to 3 sigma in definition. No change on numbers. Get optical mask team to agree.
5	CDU - Iso	No change
6	CDU - Dense	No change
7	CDU - Contact	No change
8	Linearity	No change
9	Mean to Target	No change
10	Defect Size	No change in numbers. Change color yellow from 43nm to 32nm and red below 30nm. Get optical mask team to agree.
11	Data Volume	No change
12	Design Grid	Change to 1% DRAM hp*mag
13	Substrate Defect Size	No change in numbers. Change subject heading to Blank Defect Size . Blank defect definition include substrate, ML, and cap layer. Absorber layer is not included.
14	Mean Peak Reflectivity	Change to Constant across time at > 65%. ASML will make proposal for taskforce to consider.
15	Peak Reflectivity Unif	No change. ASML will propose numbers for taskforce to consider.
16	Centroid Unif	No change. ASML will propose numbers for taskforce to consider.
17	Sidewall Angle	No change
18	Absorber LER	Converting # to LWR. Sqrt(2)* 3% Minimum Primary Mask Feature as equation - Colors Yellow for 3.7 and Red below
19	Substrate Flatness	No change





New Parameters Considered

20	Flatness w/ Compensation	Not add as new parameter. Address in next revision.
21	Surface Roughness	Not add as new parameter. Ted Liang (Intel) and Patrick Naulleau (LBNL) will lead for next revision.
22	Defect Density	Not add as new parameter.
23	Absorber Thickness	Not add as new parameter.
24	Illumination Angle	Not add as new parameter. Add as footnote to #14, 15, 16.
25	Local Slope Backside	ASML will propose numbers for taskforce to consider.
26	FWHM	ASML will propose numbers for taskforce to consider.
27	Bow	ASML will propose numbers for taskforce to consider.

Calendar of Events



- New Ideas Dec, 2009
- As preliminary Tables in Spring (equation to support)
- As Summer finalize the new tables or lines
- Dec, 2010 into print again



Backup



ITRS Roadmap for EUVL masks 2007

ignore top rows common with optical masks



<i>CD uniformity (nm, 3 sigma) [F]</i>								
<i>Isolated lines (MPU gates)</i>	4.8	4.4	4.0	3.7	3.3	2.8	2.5	looser than optical mask
<i>Dense lines DRAM (half pitch)</i>	8.6	7.5	6.5	5.8	5.2	4.6	4.1	looser than optical mask
<i>Contact/vias</i>	8.2	7.2	5.0	4.4	4.0	3.5	3.1	looser than optical mask
<i>Linearity (nm) [G]</i>	9.0	7.9	6.8	6.1	5.4	4.8	4.3	tighter than optical mask, uses .038 x halfpitch instead of .04 x halfpitch
<i>CD mean to target (nm) [H]</i>	4.8	4.1	3.6	3.2	2.9	2.5	2.3	same as optical mask
<i>Defect size (nm) [I]</i>	48	41	36	32	29	25	23	same as optical mask
<i>Data volume (GB) [J]</i>	413	520	655	825	1040	1310	1651	looser than optical mask, one generation relaxed
<i>Mask design grid (nm) [K]</i>	2	2	2	2	2	2	2	looser than optical mask (2x) from 2010 on
<i>EUVL-specific Mask Requirements</i>								
<i>Substrate defect size (nm) [L]</i>	41	39	37	35	34	32	30	EUVL only
<i>Mean peak reflectivity</i>	65%	66%	66%	66%	67%	67%	67%	EUVL only
<i>Peak reflectivity uniformity (% 3 sigma absolute)</i>	0.69%	0.58%	0.47%	0.42%	0.37%	0.33%	0.29%	EUVL only
<i>Reflected centroid wavelength uniformity (nm 3 sigma) [M]</i>	0.08	0.07	0.06	0.05	0.05	0.05	0.04	EUVL only
<i>Absorber sidewall angle tolerance (\pm degrees) [P]</i>	1	1	0.75	0.69	0.62	0.5	0.5	EUVL only
<i>Absorber LER (3 sigma nm) [N]</i>	3.9	3.4	3.0	2.6	2.4	2.1	1.9	EUVL only
<i>Mask substrate flatness (nm peak-to-valley) [O]</i>	68	59	51	46	41	36	32	EUVL only

Survey to go out requesting input for table



- Survey will go out this week, hopefully by Tuesday, to identified team plus all attendees at today's meeting.
- SEMATECH will identify suggested values, your input can be placed directly below that.

SURVEY OF EUVL MASK SPECIFIC ITEMS FOR REVISED ITRS

SEMATECH suggested changes in purple

		2009	2010	2011	2012	2013
2007 ITRS	Substrate defect size (nm) [L]	37	35	34	32	30
SEMATECH						
YOUR INPUT						
2007 ITRS	Mean peak reflectivity	66%	66%	67%	67%	67%
SEMATECH	Median Reflectivity: minimum value at center of reticle					
YOUR INPUT						
2007 ITRS	Peak reflectivity uniformity (% 3 sigma absolute)	0.47%	0.42%	0.37%	0.33%	0.29%
SEMATECH	Median Reflectivity: maximum uniformity range across quality area			0.20%	0.20%	
YOUR INPUT						
2007 ITRS	Reflected centroid wavelength uniformity (nm 3 sigma) [M]	0.06	0.05	0.05	0.05	0.04
SEMATECH	Median Reflected Wavelength range across quality area		0.06	0.06	0.06	0.05
YOUR INPUT						

ADD IN DEFINITION OF MEDIAN WAVELENGTH

SO ITRS CONSISTENT WITH REVISED SEMI STANDARD P37

Median wavelength of EUV reflectivity of mask:

$$\lambda_m = (\lambda_1 + \lambda_2) / 2$$

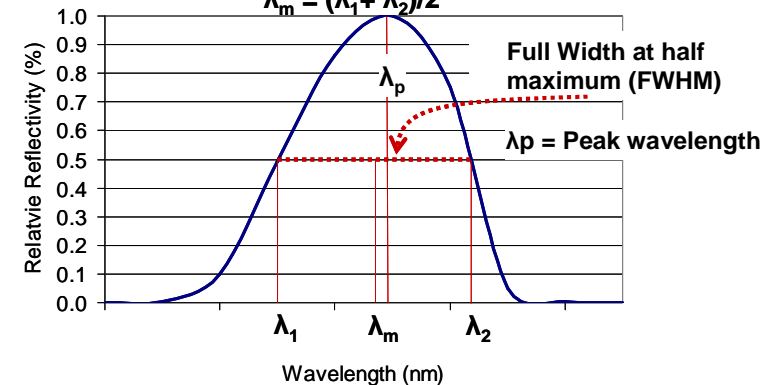


Illustration of the Median Reflected Wavelength from the Multilayer Stack

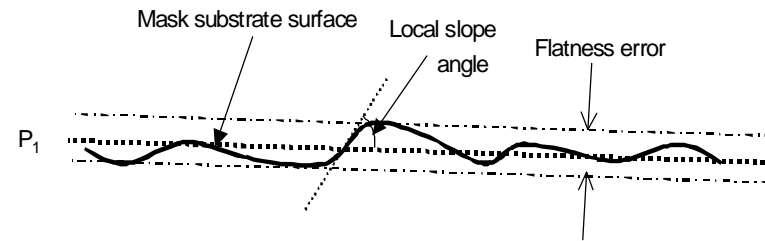
Survey to go out requesting input for table



2007 ITRS	Absorber sidewall angle tolerance (\pm degrees) [P]	0.75	0.69	0.62	0.5	0.5
SEMATECH						
YOUR INPUT						
2007 ITRS	Absorber LER (3 sigma nm) [N]	3.9	2.6	2.4	2.1	1.9
SEMATECH						
YOUR INPUT						
2007 ITRS	Mask substrate flatness (nm peak-to-valley) [O]	51	46	41	36	32
SEMATECH	Mask substrate flatness (each side) with no flatness compensation during mask write (nm peak-to-valley)			30	30	23
YOUR INPUT						

NEW ITEMS TO ADD TO ITRS TABLE

SEMATECH	Mask substrate flatness (each side) WITH flatness compensation during mask write (nm peak-to-valley)	300	300	300	300	300
YOUR INPUT						
SEMATECH	Mask substrate back surface local slope over any 20mm x 20mm area (microradians)	≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0	
YOUR INPUT						
SEMATECH						
YOUR INPUT						



Definition of Flatness Error and Local Slope Angle

P1 is the least-squares fit plane of the surface.

Yearly Timeline for updating ITRS tables

- **Thru March: Review the Tables and suggest any major changes and improvements that the table of the chapter needs.**
- **March 9: Table Chairs update status with US TWIG Litho Chair (Greg Hughes)**
- **March 12: US TWIG Litho Chair reviews input with International Litho TWIG (March Meeting)**
- **March – July: review table justifications and proposed detail changes and colors**
- **US TWIG Litho Chair to Review input with International Litho TWIG (July Meeting)**
- **August – Submit Final Tables with embedded equations, colors and definitions.**
- **September – Dec – Brain storm further improvements.**
- **US TWIG Litho Chair to Review input with International Litho TWIG (December Meeting)**