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EUV Mask Technical Session
Panel Discussions
"Traveling Through the EUV Mask Food Chain"
Panel #3: The EUV Patterned Mask Infrastructure "Glue" Member

Leica Microsystems Equipment for EUV Patterned Masks and Potential Problems We Face

- LMS IPRO5 – X/Y Registration Metrology
- LWM90XX – CD SEM for Photomask Metrology
- SB 3XXX & PML2 – Series E-beam Lithography Systems for Direct Write and Mask Fabrication

LMS IPRO5 – X/Y Registration Metrology

Lithography Metrology (Mask) Technology Requirements: EUV—Near and Long-term

Year of Production	2008	2009	2010	2012	2013	2015	2016	2018
Technology Node			hp45		hp32		hp22	
DRAM ½ Pitch (nm)	57	50	45	35	32	25	22	18
MPU/ASIC Metal 1 (M1) ½ Pitch (nm)	67	60	54	42	38	30	27	21
MPU/ASIC Un-contacted Poly ½ Pitch (nm)	57	50	45	35	32	25	22	18
MPU Printed Gate Length (nm)	32	28	25	20	18	14	13	10
MPU Physical Gate Length (nm)	22	20	18	14	13	10	9	7
EUV								
Image placement error (nm, multipoint)	13	12	11	9	8	7	6	6

	Specification LMS IPRO5 32nm node
Registration	
Short Term Repeatability (3σ)	**0.8 nm**
Long Term Repeatability (99.7%)	**1.3 nm**
Accuracy (99.7%)	**2.1 nm**
CD Measurement	
Short Term Repeatability (3σ)	**0.8 nm**
Long Term Repeatability (99.7%)	**1.2 nm**

Registration P/T Ratio of .26

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LMS IPRO5 – X/Y Registration Metrology

- Optically Based Tool
  - Limited Resolution
- Vacuum Chucking Issues
  - Deformation
  - Flatness

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LWM 90XX – CD SEM for EUV Mask Metrology

- Issues

  Charge Control (Under Investigation)

  Carry Over/Contamination and its Effects on EUV Reflectivity

  Precision P/T Requirements

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LWM 90XX – CD SEM for EUV Mask Metrology

2013

EUV								
Image placement error (nm, multipoint)	13	12	11	9	8	7	6	6
CD Uniformity (3 sigma at 4×, nm)								
Isolated lines (MPU gates), Uniformity is 10% of CD Mask error factor varies with year	3.0	2.5	2.0	1.5	1.3	0.7	0.5	0.4
Dense lines (DRAM half-pitch), Uniformity is 15% of CD Mask error factor varies with year	12.5	11.0	9.0	6.5	5.5	2.0	1.5	1.0
Wafer minimum contact hole (nm, post etch), from lithography tables	65	55	50	35	30	25	21	18
Contact/Vias, Uniformity is 10% of CD mask error factor varies with year	8	7	6.5	4.5	3.5	2.5	2	1.5
Mask CD metrology tool precision*, (P/T=0.2 for isolated lines)**	0.6	0.5	0.4	0.3	0.3	0.1	0.1	0.1
Mask CD metrology tool precision*, (P/T=0.2 for dense lines)**	2.5	2.2	1.8	1.3	1.1	0.4	0.3	0.2
Mask CD metrology tool precision*, (P/T=0.2 for contact/vias)**	1.6	1.4	1.3	0.9	0.7	0.5	0.4	0.3

“Marginal” P/T of 0.2 is 0.3 nm, 3σ for Isolated Lines

SB 3XXX & PML2 – Series E-beam Lithography Systems for Direct Write and Mask Fabrication

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2005 ITRS lithography requirements

Year of Production	2005	2007	2010	2013	2016	2019
DRAM ½ Pitch (nm) (contacted)	80	65	45	32	22	16
Flash ½ Pitch (nm) (Un-contacted Poly)	76	64	57	51	45	40
MPU/ASIC Metal 1 (M1) ½ Pitch (nm)(contacted)	90	68	45	32	23	16
MPU gate length in resist (nm)	54	42	30	21	15	11
MPU Physical Gate Length (nm)	32	25	18	13	9	7
Contact diameter in resist (nm)	111	84	56	39	28	20
Contact diameter after etch (nm)	101	77	51	36	25	18
Gate CD control (3 sigma) (nm)	3.3	2.6	1.9	1.3	0.9	0.7
Overlay [A]	15	11	8.0	5.7	4.0	2.8
Mask CD uniformity (nm, 3 sigma) isolated lines (MPU gates), binary mask [H]	3.8	2.6	1.3	1.0	0.7	0.5
Line Width Roughness (nm, 3 sigma) <8% of CD *****	3.6	2.8	2	1.4	1	0.8

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SB 3XXX & PML2 – Series E-beam Lithography Systems for Direct Write and Mask Fabrication

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Issues Facing Lithography Systems

- Resists ! (etching, absorber…..)
  - Edge Roughness
- Writing Time (single or multi beam?)
- Tool Stability
  - CD Uniformity