EUV Optics Lifetime and Contamination Workshop Highlights

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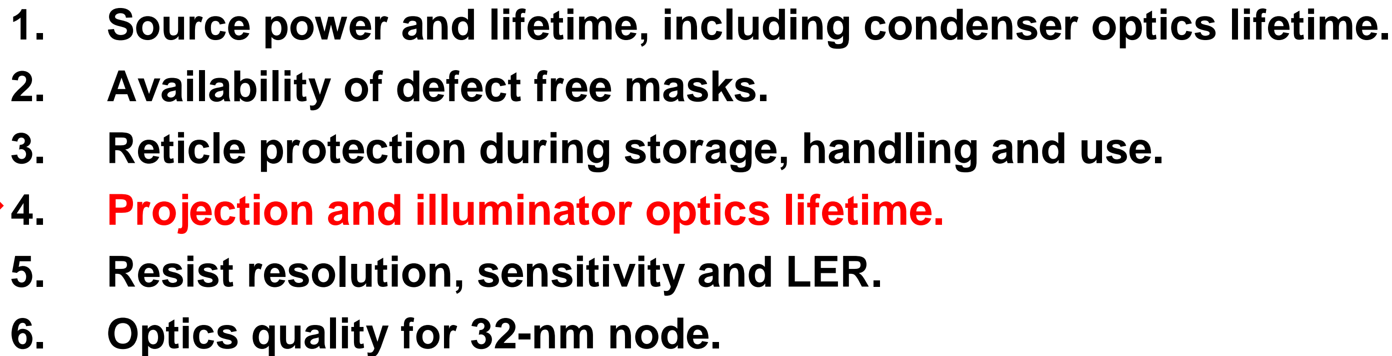
INTERNATIONAL SEMATECH

EUV Lithography Critical Issues List



- 2nd International EUV Symposium Steering Committee Critical Issues List
  1. **Source power and lifetime, including condenser optics lifetime.**
  2. **Availability of defect free masks.**
  3. **Reticle protection during storage, handling and use.**
  4. **Projection and illuminator optics lifetime.**
  5. **Resist resolution, sensitivity and LER.**
  6. **Optics quality for 32-nm node.**

- Key Tracking Metrics

Parameter	Metric	Goal	Oct-02	Mar-03	Oct-03
Source Power	Power @ Interm. Focus	>115 W	4 W	6 W	~20 W
Critical Comp. Lifetime	Number of Pulses	$>7.6 \cdot 10^{11}$	$1 \cdot 10^{8}$	$1 \cdot 10^{8}$	$1 \cdot 10^{8}$
Condenser Optics Lifetime	Pulses to 10% refl. Loss	$\sim 7 \cdot 10^{12}$	$1 \cdot 10^{8}$	$1 \cdot 10^{8}$	$1 \cdot 10^{8}$
Mask Blank Defectivity	Def/cm^2 @ PSL equiv. size	< 0.003 @ 32 nm	1 @ 150 nm	0.2 @ 150 nm	0.2 @ 150 nm
Mask Substrate Flatness	P-V	< 50 nm	300 nm	250 nm	< 100 nm
Reticle Protection	Added Def/cm^2	< 0.003 @ 32 nm	-	-	-
Projection Optics Lifetime	Time to 1% reflectivity loss	30,000 h	1,000 h	1,000 h	1,000 h
Resist Sensitivity	Sensitivity / LER	2 mJ / 4 nm	5 mJ / 7 nm	5 mJ / 7 nm	5 mJ / 7 nm
PO Box WFE (Figure)	RMS System WFE	0.25 nm	0.67 nm	0.48 nm	0.48 nm

EUV Optics Contamination and Lifetime Workshop Agenda

1. Welcome and Introduction	8:00

Session I. Projection Optics Contamination

2. Accelerated Lifetime Testing/ Outgassing Studies for Space Applications (Bruce Banks, NASA)	8:10
3. Regional Update: USA (Sasa Bajt, LLNL)	8:40
4. Questions	9:10
5. Regional Update: Japan (Iwao Nishiyama, ASET)	9:15
6. Questions	9:35
7. Regional Update: Europe (Brian Blum, ASML)	9:40
8. Questions	10:10
9. Break	10:15
10. International SEMATECH-Mediated Lifetime Testing Effort (Ginger Edwards, International SEMATECH)	10:30
11. Introduction to Panel Discussion (Manish Chandhok, Intel)	10:40
12. Panel Discussion Manish Chandhok, Intel, Moderator	11:10
13. Lunch	12:30

Projection Optics Contamination Workshop Key Learning:

1. **Test capabilities summarized for regions:**
   - Europe (replicating exposure tool environment, esp. pulsed sources)
   - Japan (synchrotron-based studies, esp. high radiative flux; novel contamination mitigation)
   - US (EUV & e-beam, physical understanding through analytical characterization, materials design knowledge)

2. **Emphasis on physical understanding needed to form basis of accelerated testing protocol:**
   - Expert testimony, echoed by exposure tool manufacturers, panelists
   - In general all materials respond differently to accelerated testing
   - Be careful that the acceleration does not introduce failure modes not seen by unaccelerated testing

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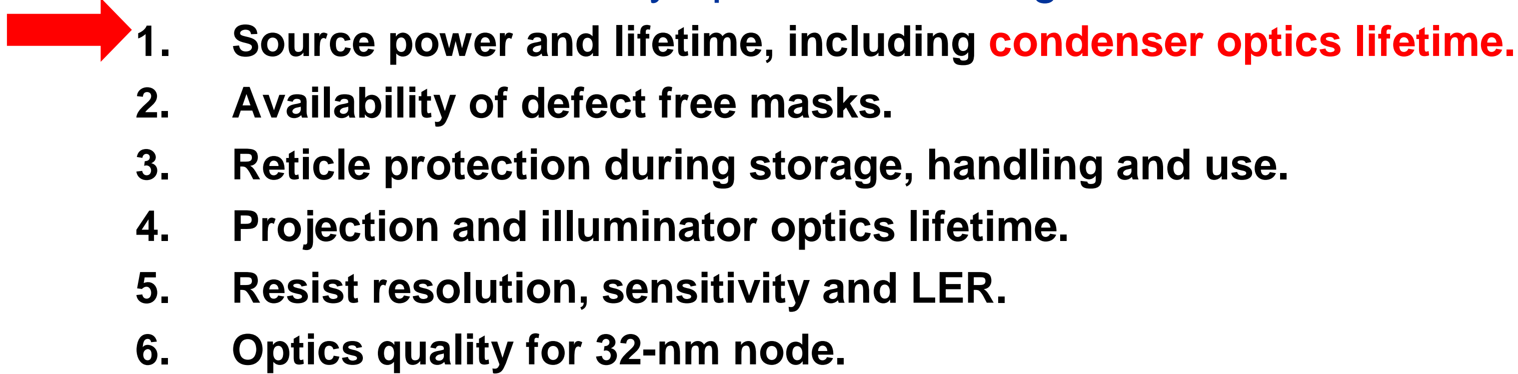

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Session II. Condenser Erosion

14. Necessary Experimental Inputs for Plasma/ Surface Interactions for Condenser Erosion (Ahmed Hassanein/ ANL)	13:30
15. Regional Update: USA (Lennie Klebanoff, Sandia)	14:00
16. Questions	14:30
17. Regional Update: Japan (Hiroshi Komori, EUVA)	14:35
18. Questions	14:55
19. Regional Update: (Brian Blum, ASML)	15:00
20. Questions	15:30
21. Break	15:35
21. International SEMATECH-Mediated Condenser Erosion Testing Effort (Ginger Edwards, International SEMATECH)	15:50
22. Introduction to Panel Discussion (Robert Bristol, Intel)	16:00
23. Panel Discussion Robert Bristol, Intel, Moderator	16:30
24. Adjourn	18:00

Condenser Erosion
Key Learning from Workshop:

1. **Test capabilities summarized for regions:**
   - Europe (debris mitigation)
   - Japan (Ion characterization (TOF); Ion mitigation; erosion testing (ions, LPP)
   - US (LPP source; ETS learning; COR & plasma characterization; in situ erosion tests; extensive materials testing)

2. **Debris mitigation to have larger impact than materials testing**
   - Models needed, but more short term impact to model sources
   - Discussion eclipsed by Xe vs. Sn (other); LPP vs. GDPP