EUV Mask infrastructure:
Performance Data and Status of the
AIMS™ EUV system for actinic mask review

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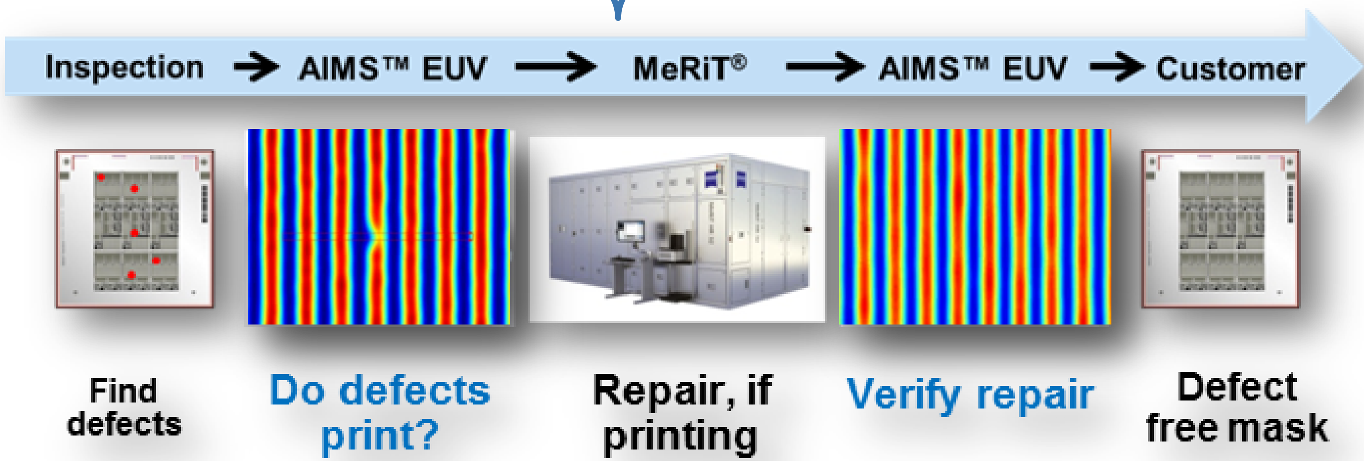
2016-10-24

AIMS™ EUV required for defect free EUV mask infrastructure



4 AIMS™ EUV tools in integration at ZEISS

Customer1

Prototype

Customer2

Customer3

Machine automation

Performance tuning to spec

Application automation

Calibration & adjustment

Base tool capability launch

Component and module launch

HW Integration

Tool phases

Requirements for an AIMS™EUV

Core measurement capabilities

Productivity

Core measurement performance

Application

Core measurement capabilities established:
11 EMI access campaigns run

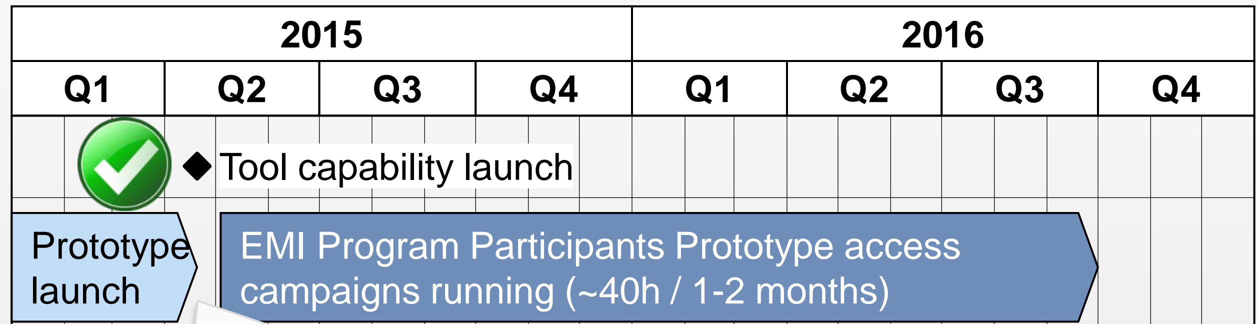
Core measurement capabilities

Productivity

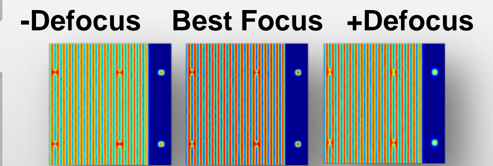
Core measurement performance

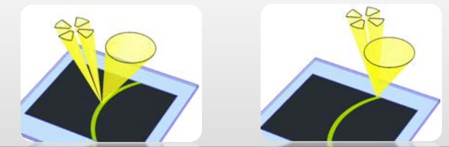
Application

EUV Mask Infrastructure (EMI) development program with SUNY Poly SEMATECH



- Through focus aerial image acquisition
- Scanner equivalent illumination
- Chief Ray Angle (CRA) emulation
- Mask handling





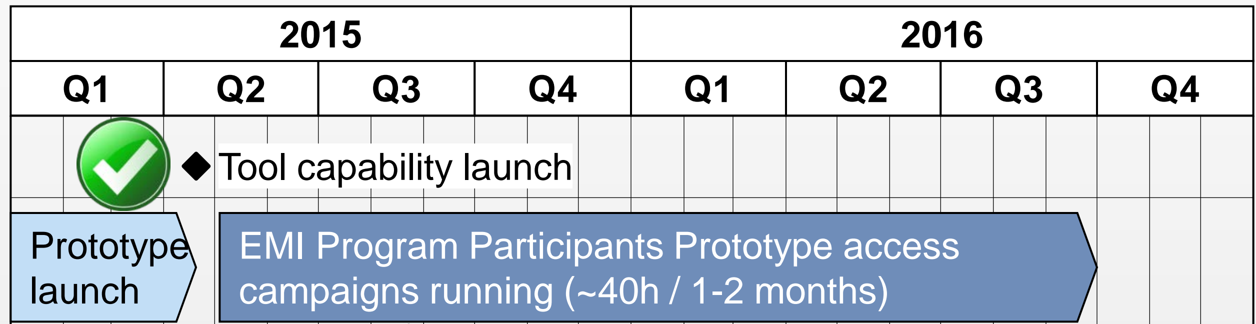
Throughput demonstrated on prototype exceeds specifications

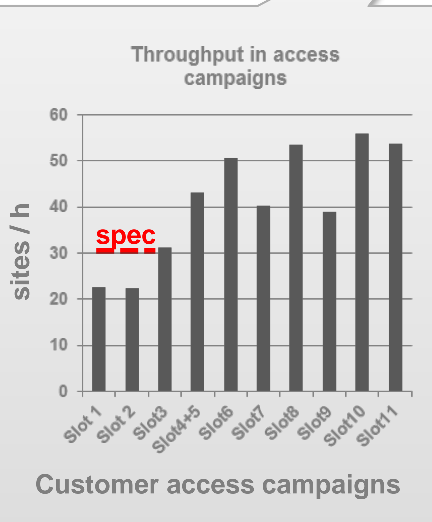
Core measurement capabilities

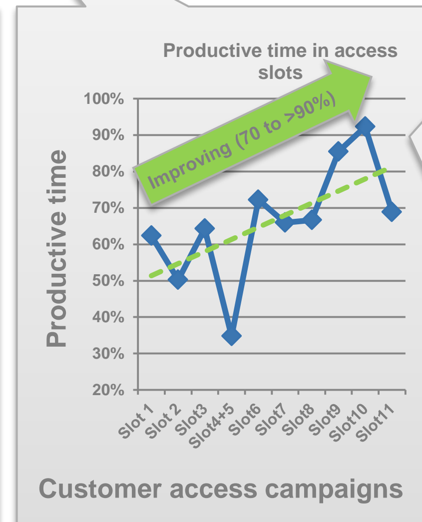
Productivity

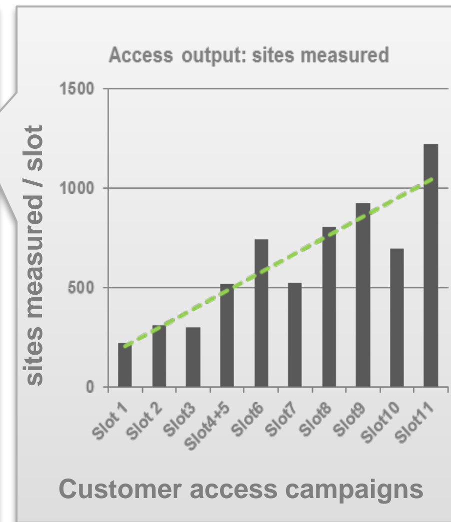
Core measurement performance

Application









Core measurement performance established

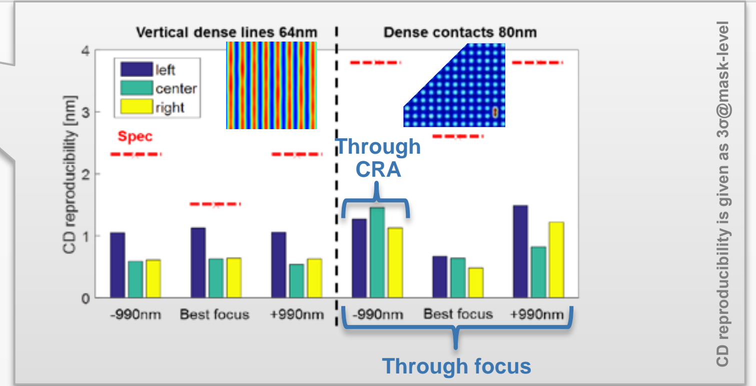
Core measurement capabilities

Productivity

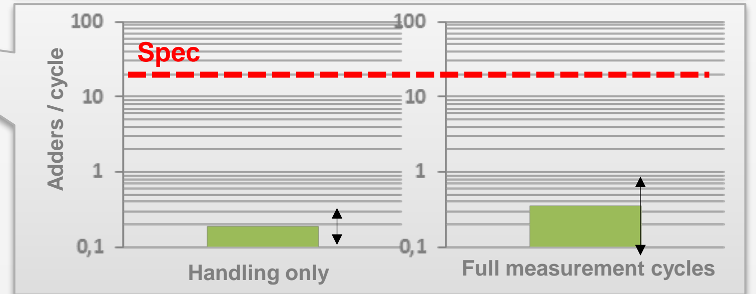
Core measurement performance

Application

- CD reproducibility in spec

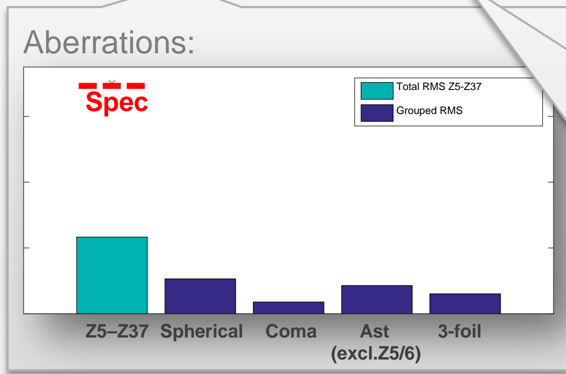


- Defectivity tested: <1adder / cycle

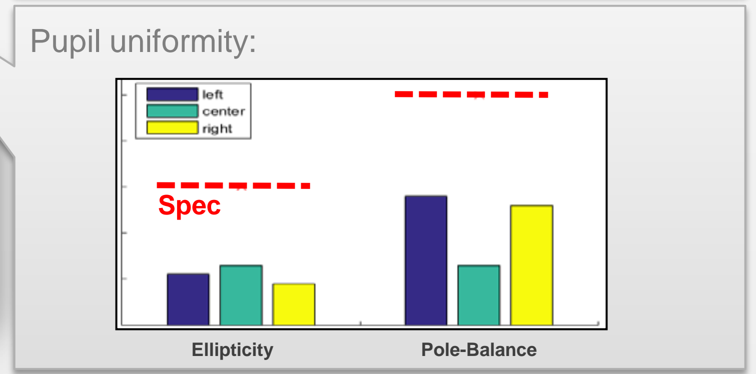


- Optics performance

Aberrations:



Pupil uniformity:



Speckles caused by mask surface roughness can be quantitatively investigated

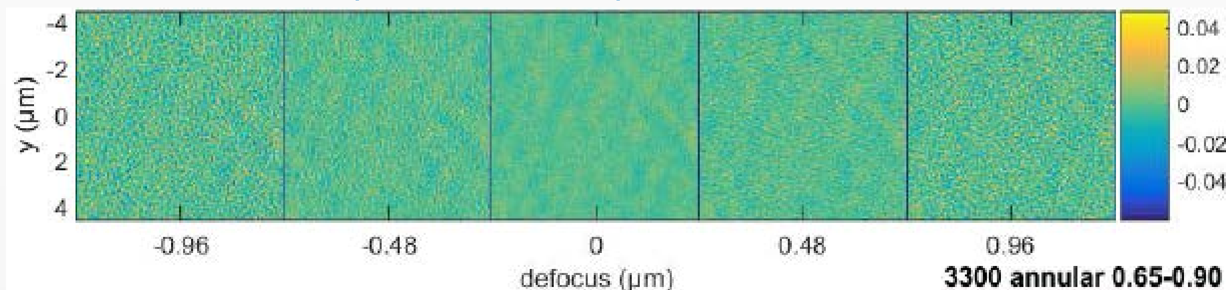
Core measurement capabilities

Productivity

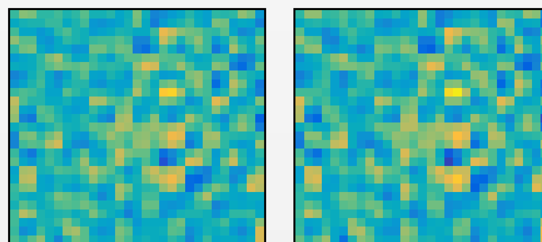
Core measurement performance

Application

Focus stack of clear pattern shows speckles:

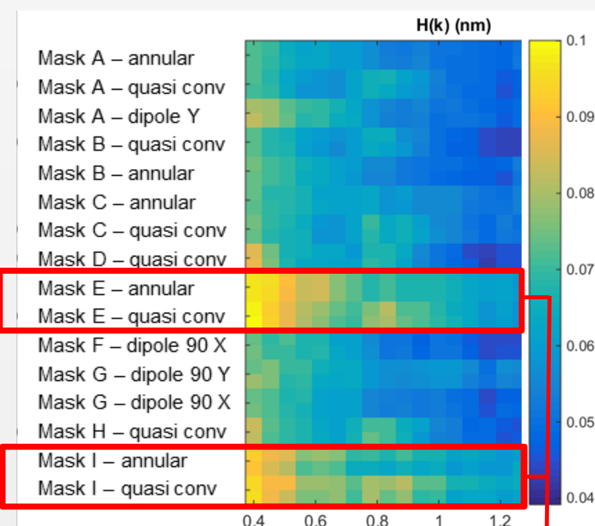


Speckle-pattern is stationary with stage movement and defocus → originates from mask:



Zoom into 2 images

Height spectrum (roughness) can be extracted:



Higher roughness: different blank quality?

See also:
- S.A. George et al. "Replicated mask surface roughness effects on EUV lithographic patterning and line edge roughness"
- R.A. Claus et al. , "Aberration estimation using EUV mask roughness'"
- R.A. Claus et al. , "Phase Measurement of EUV Mask Defects"

Defect disposition and Repair verification

Core measurement capabilities

Productivity

Core measurement performance

Application

Inspection → AIMS™ EUV → MeRiT® → AIMS™ EUV → Customer

Find defects

Do defects print?

Repair, if printing

Verify repair

Defect free mask

Defect disposition

Repair verification

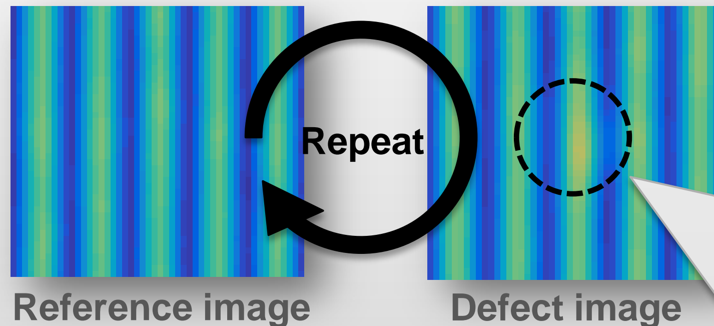
Defect disposition by AIMS™ EUV and FAVOR® meets requirements

Core measurement capabilities

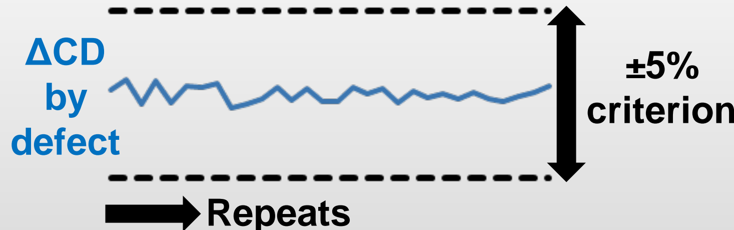
Productivity

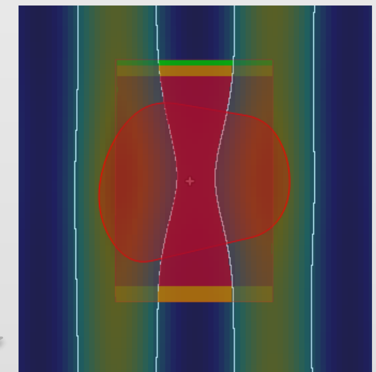
Core measurement performance

Application



CD change by defect analyzed with FAVOR® AUTO ANALYSIS





[9985-61] Garetto et al

Merit® repair verification by AIMS™ EUV available

Core measurement capabilities

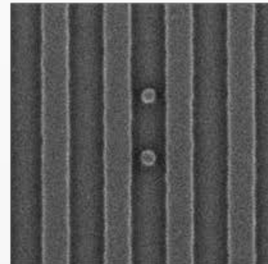
Productivity

Core measurement performance

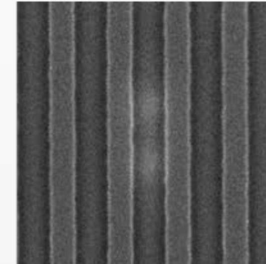
Application

Examples of repairs verified by AIMS™ EUV:

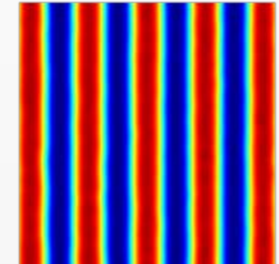
Two pindots (∅=80 nm)



Pre-Repair SEM

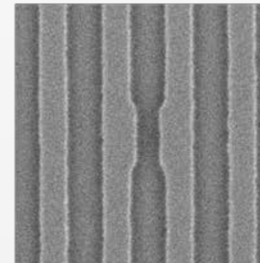


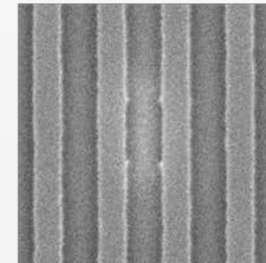
Post-Repair SEM

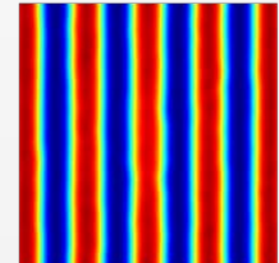


Post-Repair EUV-AIMS

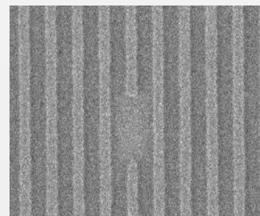
Internal extrusion: 30×300 nm^2



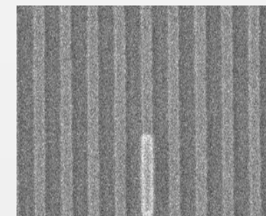




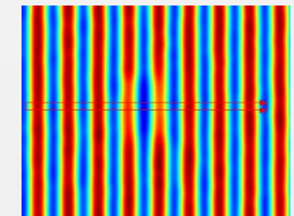
Example of over-depo repair:



Pre-Repair SEM



Post-Repair SEM



Post-Repair AIMS™ EUV

Summary

Core measurement capabilities — Aerial imaging, CRA emulation, Scanner equivalent illumination and mask handling available

Productivity — Prototype throughput exceeds spec level

Core measurement performance — CD reproducibility and optics performance in spec (Mask effects are considered in tool qualification)

Application — Defect disposition reproducibility meets requirements, repair reviews demonstrated

1st customer tool qualified at core performance
Next: Delivery

Customer1

Prototype

Customer1		Prototype
✓	CD repro	✓
✓	Optics	✓
✓	Runrate	✓
✓	Defectivity	✓
✓	Source ATP	
Running	Disassembly	

Tool phases

- Machine automation
- Performance tuning to spec
- Application automation
- Calibration & adjustment
- Base tool capability launch
- Component and module launch
- HW Integration

Acknowledgements

The authors would like to thank SUNY Poly SEMATECH and the EMI consortium for their support and contributions to this project

Thank you for your attention