Optics and Mask Contamination in SEMATECH EUV Micro-Exposure Tools

IEUVI Optics Contamination / Lifetime TWG
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There are two SEMATECH EUV micro-exposure tools (METs):
- SEMATECH North, Albany, NY
- Lawrence Berkeley National Laboratory, Berkeley, CA

SEMATECH North EUV MET is a stand-alone tool, has own EUV source.

SEMATECH Berkeley EUV MET is synchrotron-based.

Tools operations:
- Albany: Mid 2005 - present
- Berkeley: Feb 2004 - present
Provides leading-edge EUV lithography capabilities.

The Advanced Light Source synchrotron facility at Lawrence Berkeley National Laboratory provides a robust, debris-free, powerful source of EUV.

This unique programmable coherence exposure tool provides unparalleled imaging capabilities (down to 12 nm) enabling advanced resist, mask, process, and metrology methods testing.
SEMATECH North EUV MET
High-throughput resist testing tool

- 0.3 NA tool
- TEL coat track
- Thermawave (Film thickness metrology)
Click to View

- Optical Path
  - Source - N1
  - N1 - N2
  - N2 - Reticle
  - Reticle - Wafer

Optical layout
SEMATECH
North EUV MET

Courtesy of Matt Malloy

03/09/2007
SEMATECH Berkeley MET Beam Path

Final beamline optics

M5

M6
Experimental parameters

- There is contamination on mask and illumination optics, in both tools. We do not know about the projection optics.
- Photon density and flux are higher on the mask and illumination optics than on projection optics.

**SEMATECH Berkeley EUV MET:**
- Estimated accumulated dose on field (mask):
  - Worst field: \( \sim 600,000 \, \text{mJ/cm}^2 \)
  - Max peak power:
    - Beam essentially cw, peak power density \( \sim 25 \, \text{mW/cm}^2 \)
  - Typical background pressure: \( 6 \times 10^{-8} \, \text{torr} \) (mainly water)

**SEMATECH Albany EUV MET:**
- Mid-2005 (tool installation): \( \sim 50 \, \text{shots/mJ} \) (for \( E_0 \) required)
- Nov 2006: \( \sim 350 \, \text{shots/mJ} \) (for \( E_0 \) required) → 7x due to optics contamination
- Shots on N1, N2, G2, G2 mirrors: \( \sim 220 \, \text{million} \)
- Shots on mask: \( \sim 165 \, \text{million} \)
- Typical background pressure: \( \sim 10^{-7} \, \text{mbar} \)
SEMATECH North EUV MET

- RGA trace (not measured in main chamber)
- Main chamber base pressure: $\sim 10^{-7}$ mbar
Contamination on illumination optics mirror N1 (old vs. new)
Contamination on illumination optics mirror N2
Contamination on mask
Contamination on mask
Summary

• There is contamination on illuminator mirrors and masks in both SEMATECH EUV METs, Albany and Berkeley.

• Contamination is radiation-dependent.

• Currently analyzing contamination on mirrors and mask.