EUV microexposure capabilities at the ALS using the 0.3-NA MET optic

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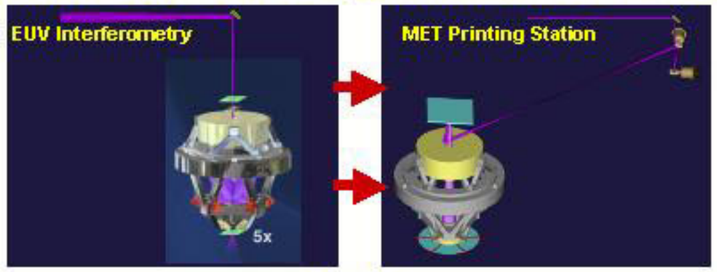
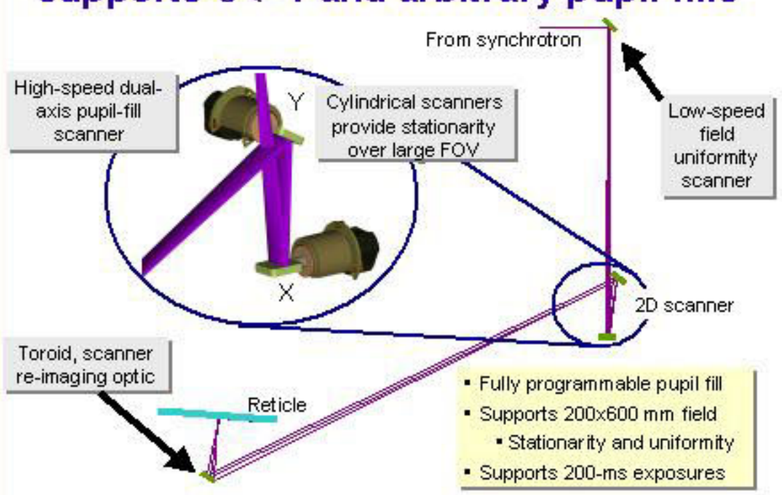
New 0.3-NA MET-based microlithography station soon to be operational at the ALS



Features

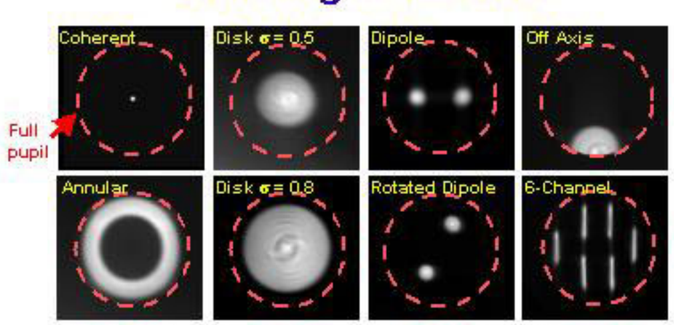
- Sub-30-nm resolution 0.3-NA MET optic
- 200x600 μm field of view
- @-λ interferometry support
- Programmable coherence illuminator
- Reticle dose/illumination sensor
- Standard and custom reticle support
- Reticle stage with manual transfer
- Sub-10-nm resolution height sensor
- Wafer dose sensor (1% dose control)
- 4-inch wafer E-chuck
- Wafer stage with vacuum load-lock manual transfer
- Sub-10-nm-resolution focus stage
- Pupil-fill monitor

Programmable coherence illuminator supports σ<=1 and arbitrary pupil fills



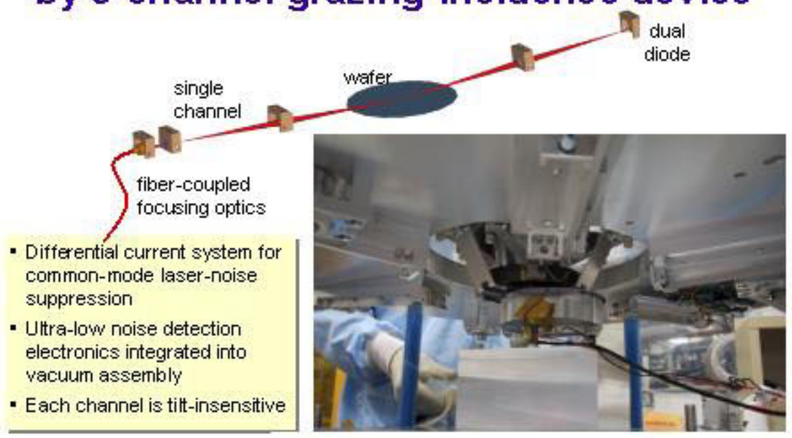
- Fully programmable pupil fill
- Supports 200x600 mm field
  - Stationarity and uniformity
- Supports 200-ms exposures

Typical EUV pupil fills achieved with scanning illuminator

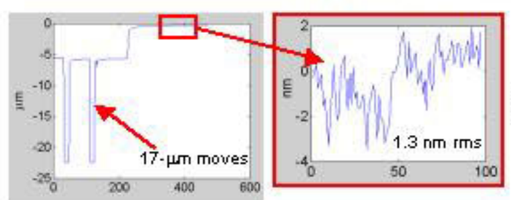


Pupil fills recorded in ETS-based ALS printing station

Print-site wafer height sensing provided by 3-channel grazing-incidence device



- Differential current system for common-mode laser-noise suppression
- Ultra-low noise detection electronics integrated into vacuum assembly
- Each channel is tilt-insensitive

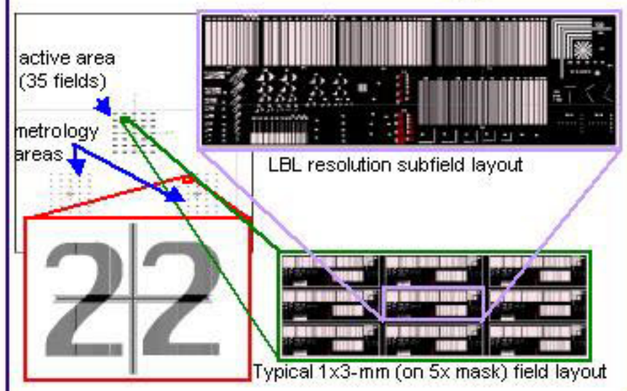


Sensor demonstrated to have 1.3-nm noise floor/resolution

Height-sensor installed and preliminary alignment in process

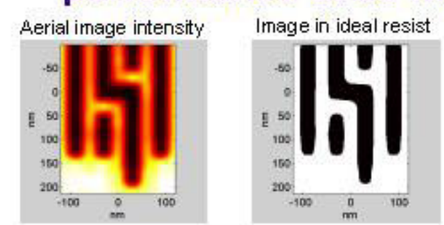
Fabrication of subsystems complete and final assembly underway

6-inch MET mask supports 35 fields

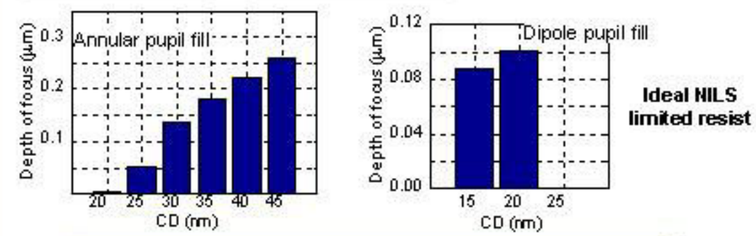


- Mask fabrication underway
- Patterning by CXRO e-beam *Nanowriter*
- Etch by *Intel*
- Support 30-nm nested features
- 35 independent 200x600 μm fields
- Integrated metrology features for field selection

Modeling confirms good imaging performance at 30 nm and below

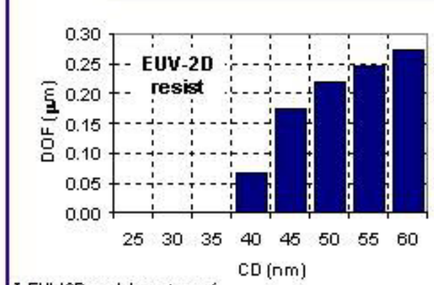


- Modeling based on:
  - Visible-light wavefront (0.56-nm rms in first 37 Zernikes)
  - 30-nm features
  - Annular illumination $0.3 < \sigma < 0.8$



Good process window predicted assuming ideal resist

- Vertical lines and spaces
- Process window limit: +/-10% CD change, NILS > 2
- DOF based rectangular process window with 10% total EL



* EUV-2D model courtesy of Stewart Robertson, Shipley

EUV-2D not expected to support 0.3-NA MET optic resolution limit

- Latest Shipley EUV-2D model*
- Resist thickness 80-nm
- Process window limit: +/-10% CD change, no sidewall constraints
- DOF based on rectangular process window with 5% total EL
- No measurable DOF below 50-nm CD with 10% EL

Summary

- @-λ cross field alignment of MET optic completed
- Final assembly underway, first results expected in November
- Programmable illuminator expected to enable 15-nm resolution
- System to provide early learning for 32-nm node
  - High-resolution resist development
  - High-resolution mask qualification
  - Defect printability, mitigation, and repair