New capability at NIST for reflectivity measurements of large EUVL optics

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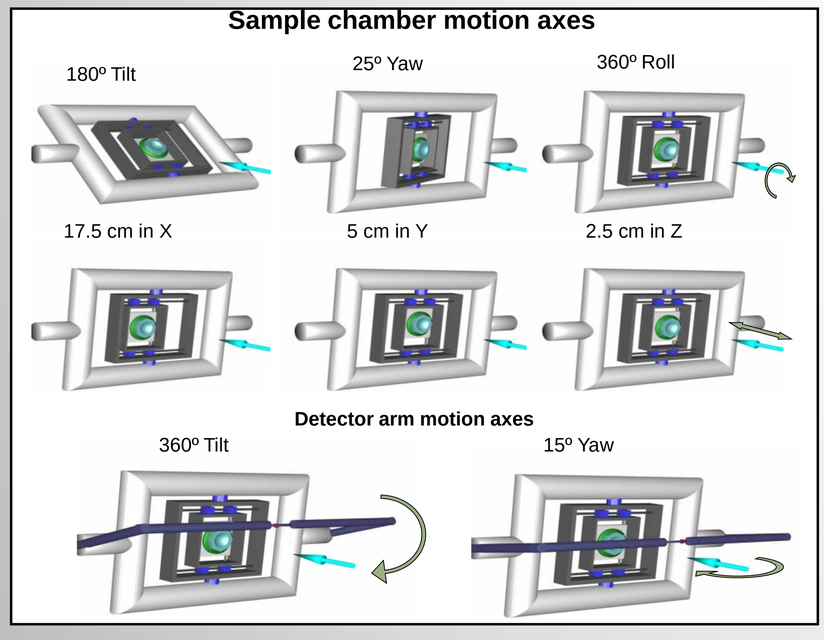
NIST has expanded its capabilities for EUV reflectivity measurements to accommodate larger optics with steeper surface slopes. The NIST EUV reflectometry facility has been upgraded to now be capable of measuring samples up to 45 cm in diameter with surface slopes up to 50 degrees. As before, measurements at 13.5 nm will be made with an absolute wavelength accuracy of ± 0.01 nm and reflectivity accuracy of 0.25%. This new capability will allow NIST to make accurate reflectivity maps on some new classes of large collector mirrors now in the development. Future reflectometer upgrades that are currently in the design phase will also be presented. These include expanded wavelength range to provide improved coverage of shorter wavelengths down to 2.8 nm and higher wavelength resolution in the 6 nm range to help provide support for 6.x nm lithography.

NIST/DARPA EUV Reflectometry Facility



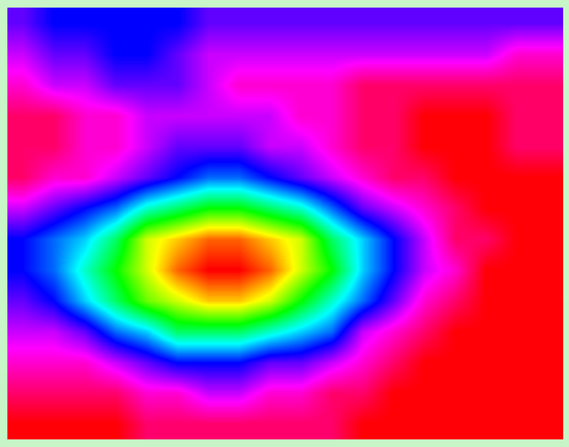
Current capabilities

Sample chamber

- Samples up to 35 cm diameter, 40 kg mass.*
- Six axes sample motion, three axes detector motion.
- EUV spot size: 1mm x 1mm (FWHM)
- Can be fitted with external end-stations for assembled instrument calibration.
- Class 10,000 cleanroom on the endstation for sample insertion

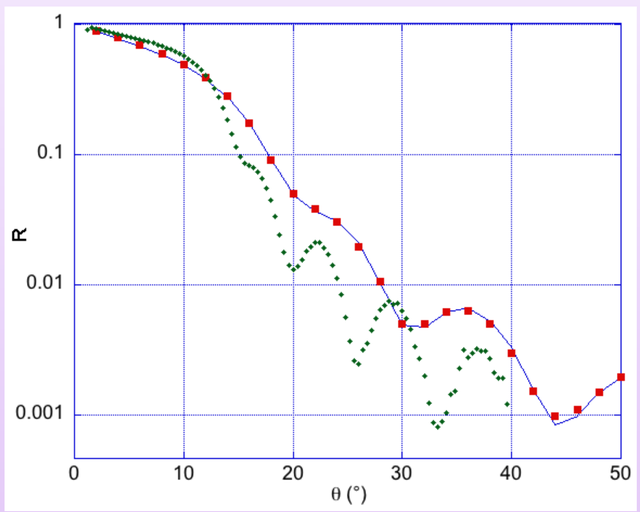
Monochromator

- VLS grating:
  - 600 mm^{-1}, 7 nm - 35 nm*
- Wavelength Uncertainty: 0.01 nm
- High throughput (P_{EUV} > 1 μW)
- Fixed exit slit
- Reflectivity uncertainty: ~ 0.25% λ near 13 nm

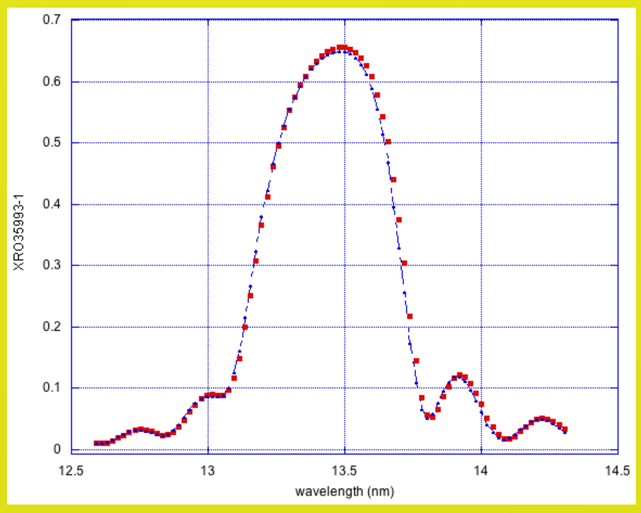


This is a 2D reflectivity scan of a sample that has undergone a witness-sample carbon growth test. The scanned area is 9 mm by 14 mm; the total carbon thickness is less than 1 nm, and the reflectivity loss full scale is about 0.9 %.

Photoresist absorption

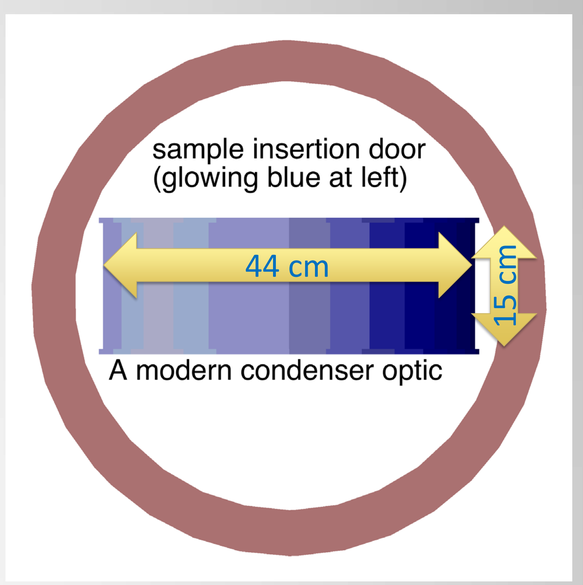


Reflectance at 13.5 nm vs. grazing angle of a typical organic resist (green) and an inorganic resist made by Inpria Corporation (red squares). Optical constants can be obtained by fitting the measurement results to the Fresnel equations (blue curve). Data indicate that the inorganic resist is four times as absorbing as most inorganic resists.



A sample reflectivity curve

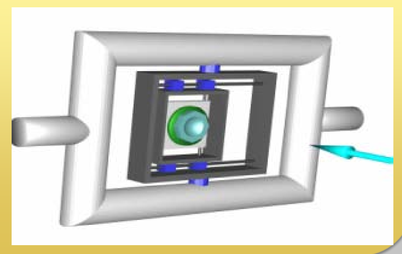
Modifications



Modern collection optics are larger than our original motion system allowed, necessitating modifications to our reflectometer

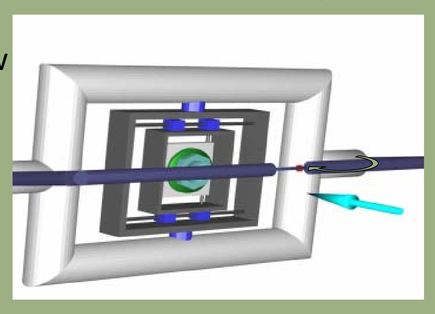
Platen has been mounted off-center to allow asymmetric line scans.

+22.5/-12.5 cm in X



Detector motion has been extended to allow non-vertical reflection measurements. This allows measurement of surfaces with steeper slopes.

+5º/-55º detector yaw



*Placing the sample turntable stage off-center allows us to put the beam at any point on the surface of a sample up to **45** cm in diameter. Placing the detector yaw off-center allows us to measure surfaces with slope up to **50°** using out-of-plane reflections.

*A new monochromator has been designed incorporating a 1500 mm^{-1} grating and new mechanics. The upgrade will allow scanning to the carbon edge and high resolution at **6.8** nm for next-generation EUVL optics.

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