

Compact Laser Plasma Reflectometer for Process Control of EUV Lithography Mask Blank Multilayer Coatings

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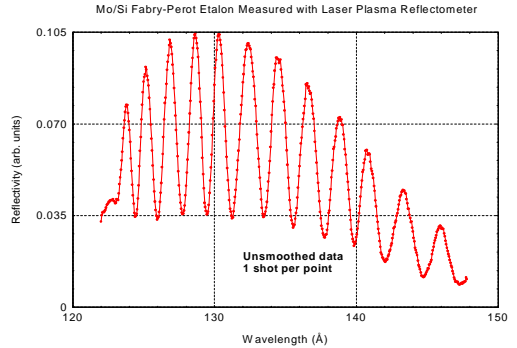
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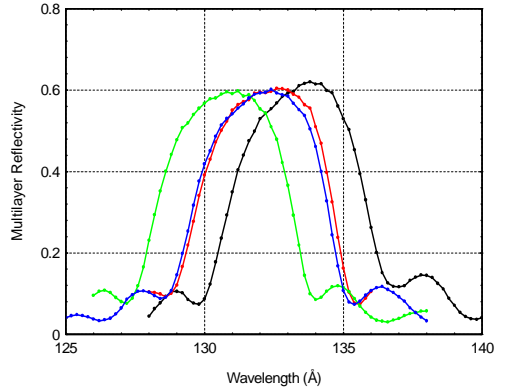
ABSTRACT

EUV lithography uses a reflective mask, and reflectivity at EUV wavelengths is obtained by coating a mask substrate with multilayers. The present mask blank is a silicon wafer coated with molybdenum-silicon multilayers to maximize reflectivity at 13.4 nm. The mask blank is later coated with an absorbing film patterned with the desired integrated circuit features. The multilayer coating must be very uniform over the surface area of the blank. This imposes stringent requirements on the sputter deposition process used to coat the masks. At present the process is monitored by transporting the masks to an EUV reflectometer at a synchrotron radiation center such as the Advanced Light Source, for measurement of the reflectance curves. This is inconvenient and furthermore risks particle contamination of the masks.

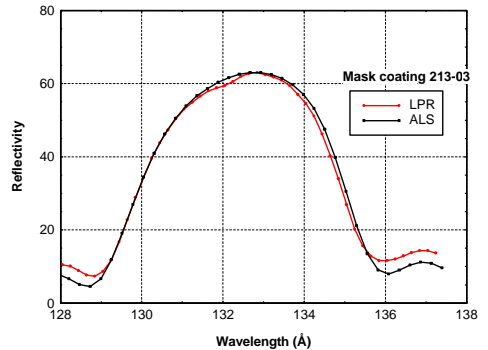
Based on a laser plasma source, we have developed an *in-situ* reflectometer that is permanently attached to the multilayer deposition tool at LLNL. This instrument can make reflectivity measurements from 10 to 16 nm region to an accuracy of 1% and measurements of the peak wavelength (centroid of the reflectivity curve) to 0.1 Å over the surface of a 200 mm diameter wafer measured relative to a standard multilayer mounted on the X-Y stage. The masks are loaded into, and removed from the reflectometer by the Brooks robot on the deposition tool, so the measurements are made without breaking vacuum. The instrument is briefly described and some representative results presented



Reflectivity of Mo/Si ML mask coatings Measured with Laser Plasma Reflectometer



Comparison of measurement Laser Plasma Reflectometer and ALS beamline 6.3.2



Laser Plasma Reflectometer



Target door closed



Target door open

SPECIFICATIONS

(red shows performance achieved)

- Laser Plasma Reflectometer to be mounted as an *in-situ* monitor for the Veeco mask deposition tool at LLNL
- Measurement area – 200 mm diameter wafer ✓
- Measurement spot size – less than 5 mm diameter (less than 2 mm)
- Wavelength range – 11 to 16 nm ✓
- Wavelength accuracy – 0.01 nm (.001 nm)
- Reflectivity accuracy – 1% ✓
- Data rate – 1 point/sec or greater ✓
- Data to be obtained at 1 laser shot per point ✓
- 40,000 shots per target change (120,000 shots per target)

Instrument delivered to LLNL October 2000

CONCLUSIONS

- Compact Laser Plasma reflectometer has been constructed and delivered
- Specs. for *in-situ* monitoring of mask deposition have been met or exceeded
- Laser plasma reflectometry is clearly a viable option for mask measurement
 - System can be modified and improved for mirror measurement
- Multilayer Fabry-Perot makes an excellent portable wavelength standard

▪ The Laser Plasma Reflectometer is now commercially available!