Multilayer Filter Using the Borrmann Effect for EUV Source Monitoring

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Introduction

- EUV spectra generated by Laser-Produced Plasma (LPP) are complex:
  - depend strongly on the excitation conditions
  - depend critically on surface contamination of optics
- EUV Lithography needs monitoring of in-band radiation power (13.5 nm)
- Development of a versatile method using the Borrmann effect [1,2] in EUV multilayer optics [3], to monitor easily the radiation power at a selected \( \lambda \):
  - in transmission, - at normal incidence,
  - wavelength tunable, - narrow bandwidth.

Borrmann effect in EUV multilayer optics

- Multilayer stack illuminated with EUV radiation \( \Rightarrow \) Formation of standing wavefields

Zr-coated Ni/Si Multilayer Borrmann Filter for 13.5 nm

- Transmission peak at \( \lambda = 13.5 \) nm, with a 0.23 nm bandwidth and a 1% transmittance

- Zirconium coating suppresses the 18–42 nm transmission window, without hindering the peak at 13.5 nm
- For comparison, the figure on the right shows the transmittance of the same Ni/Si filter without the Zr coating (but optimized for same peak transmittance)

Transmitted EUV spectrum

- The first figure shows the calculated EUV spectrum emitted by a Sn LPP source

- The second figure shows the calculated transmitted EUV spectrum from the above source, using a Zr–coated Ni/Si Multilayer Borrmann Filter optimized for 13.5 nm

Wavelength tunability

- Wavelength tunability can be achieved by modifying either the incidence angle or the bilayer thickness

Technical realization

- No substrate can be present behind the multilayer filter, as it would absorb all signal. Two solutions can be considered:
  - Freestanding Method
  - Coating Method

  As the freestanding method appears difficult, due to the stress within the multilayer stack, the coating method is the one actually being worked on.

Summary

- We present an application of the Borrmann effect in multilayer optics
- We present first calculations for XUV filters with very high resolution
- Deposition and measurements of the first samples is ongoing