Translating the Borrmann effect into narrow-band EUV transmission windows

J.L.P. Barreaux1,*, H.M.J. Bastiaens1, I. Kozhevnikov2, F. Bijkerk2 and K.-J. Boller1
1Laser Physics and Nonlinear Optics, MESA+ Institute for Nanotechnology, University of Twente, The Netherlands
2Laser Optics, MESA+ Institute for Nanotechnology, University of Twente, The Netherlands
3Institute of Crystallography, Russian Academy of Sciences, Leninsky Prospect 59, Moscow 119333, Russia
*J.L.P.Barreaux@utwente.nl

Introduction

- EUV spectrum generated by Laser-Produced Plasma (LPP) are complex:
  - depends strongly on the excitation conditions
  - depends critically on surface contamination of optics
- EUV Lithography needs monitoring of in-band radiation power (13.5 nm)
- Need for a method to monitor easily the radiation power at a selected $\lambda$
  - In transmission
  - At normal incidence
  - Wavelength tunable
  - Narrow bandwidth
- Presentation of a method using the Borrmann effect in multilayer optics

Borrmann effect in EUV multilayer optics

How to make a broadband absorber spectrally selective?
- By placing it in a spectrally selective environment!
- Consider a simple resonator:

• This is the essence of the Borrmann effect!

Borrmann effect

- In a crystal [1,2]:
  - Matching of the standing electric field minima with the crystal lattices
  - Spectrally selective increase in X-ray transmission
- In a multilayer stack [3]:
  - Matching of the standing electric field minima with the thin absorbing layers
  - Resonant enhancement of the transmittance for a narrow bandwidth

Calculated transmission spectra

Filter centered at 13.5 nm (Ni/Si)
- 0.25 nm bandwidth achieved with 1% transmission

Technical realization [4,5]

Incoming Beam

Freestanding ML Structure

Substrate

ML Structure

XUV Photodiode

Deposit coating here. Problem = solved!

Summary

✓ We present an application of the Borrmann effect in multilayer optics
✓ We present first calculations for XUV filters with very high resolution
✓ Process of deposition on the photodiode needs to be developed

References: