Large area sputtering system for EUVL optics

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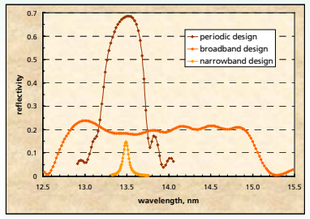
Introduction

According to the optics requirements of an EUVL tool, the accurate deposition of high reflective and laterally graded multilayers on ultraprecisely polished substrates can be regarded as one of the major challenges of EUV lithography development today. To meet these requirements, a **N**ew **E**UV **S**puttering **SY**stem – NESSY has been developed.

The dc magnetron sputtering system is equipped with four rectangular magnetrons, 600 mm x 125 mm each. The simultaneous coating of two Ø 450 mm substrates or three Ø 300 mm substrates can be realized. The substrates can be spun up to 500 rotations per minute during the deposition process. The target-substrate-distance is variable from 50 mm to 150 mm allowing the installation of moving shutters to realize lateral thickness gradients of the sputtered multilayer. The system is load locked and cryopumped. The base pressure is well below $8*10^{-9}$ mbar.

Special effort has been made to construct the cathodes. Different configurations of the magnets have been successfully realized in order to assure highest flexibility for different coating materials in terms of homogeneity requirements and target utilization. All magnetrons work stable at a working pressure of less than $7*10^{-4}$ mbar in argon atmosphere. A lateral period homogeneity of +/- 0.1 % on 300 mm has been demonstrated recently with Mo/Si multilayers.

Mo/Si multilayers

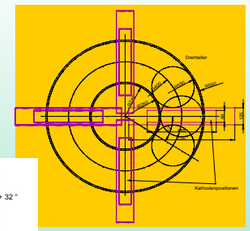


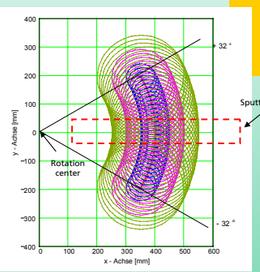
R = 68.8 %
λ = 13.5 nm
FWHM = 0.50 nm
N = 60

R ≈ 20 %
λ = 13 - 15 nm
FWHM = 2.33 nm
N = 60

R = 14.6 %
λ = 13.5 nm
FWHM = 0.077 nm
N = 40

Conception





Substrate path underneath the sputter source

r = 0, 50, 100, 150 mm

r_z: 400 mm
v_{rot}: 3 rpm
v_{spin}: 500 rpm

Specifications

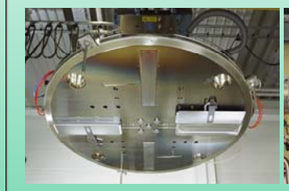
Conception	sputter down, rotation of fast spinning substrates
Substrate size	up to 450 mm diameter
Substrate stations	2 stations for Ø 450 mm or 3 stations for Ø 300 mm
Sputter sources	4 sputter sources, 600 mm x 125 mm
Thickness homogeneity	+/- 0.1 % on 300 mm
Sputter distance	50 mm … 150 mm
Substrate rotation	≤ 5 per minute
Substrate spin	≤ 500 per minute
Base pressure	< $8*10^{-9}$ mbar
Working pressure	$7*10^{-4}$ mbar

New EUV Sputtering System - NESSY

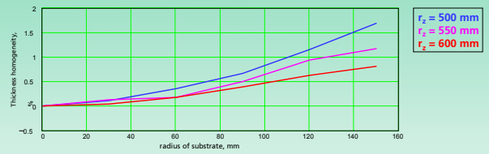
LEYBOLD OPTICS

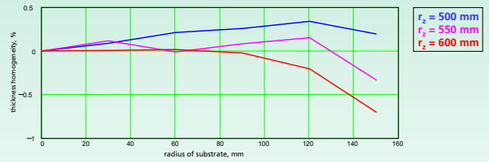
Photo (1934):

Loch Ness Monster
NESSIE

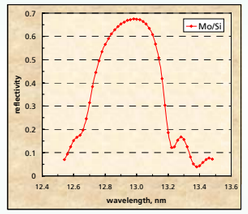


Simulation of homogeneity – 600 mm x 125 mm sputter source





First results



R = 67.4 %

λ = 13.0 nm

Measurement (θ = 1.5°):

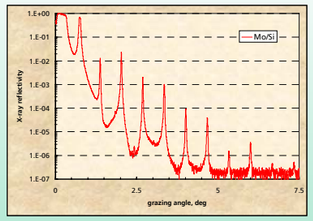
Physikalisch-Technische Bundesanstalt Berlin, BESSY II

Deposition parameter:

P: $6*10^{-4}$ mbar
h_0: 65 mm
$v_{rot\ Si}$: 0.68 rpm
$v_{rot\ Mo}$: 1.32 rpm
v_{spin}: 500 rpm
$P_{Mo/Si}$: 1000 W

Design parameter:

N: 60
d_{Mo}: 3.13 nm
d_{Si}: 3.50 nm



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