DEVELOPMENT OF ULTRA-SMOOTH MULTILAYERS FOR EUV AND X-RAY PTICS

Name: Doyeon Jin Master Physics @ TU Dresden Fraunhofer IWS, since 15th of April, 2024 Date: 6th of August, 2024

INTRODUCTION





- Goal is to achieve Rq surface roughness less than 0.1 nm for the state of art X-ray and EUV mirrors.
- X-ray applications include synchrotron beamlines and microscopy.
- EUV lithography optics @ 13.5 nm
- A linearly translational, tiltable and rotatable ion beam souce will be used to process rough samples to meet the requirements for these applications.

NAVIGATOR: ION BEAM SPUTTERING DEPOSITION







Neutralizer – supplying electrons to neutralize the ion charges

Secondary Source – for etching

DEPOSITION: PRIMARY SOURCE



Primary Source		
Inert gas	Argon 23 sccm	
Positive voltage	600 - 1800 V	
RF power	275 W	
Target	Deposition time	
Silicon	20 min.	
Molybdenum contrast layer	5 sec.	
Neutralizer		
Inert gas	Argon 6 sccm	
Negative voltage	27 V	
RF power	50 W	

SUBSTRATE HEIGHT DURING DEPOSITION



Substrate distance	-40 mm to -130 mm
Primary Source Voltage & RF power	1400 V / 275 W
Conclusion	Optimal height around -80 mm
Deposition time	10 min.

X-RAY REFLECTOMETRY (XRR)



Material	Thickness
Silicon	~110 nm
Molybdenum	~50 nm





SECONDARY ION SOURCE FOR ETCHING



Secondary source	
RF power	100 W
Voltage	400 V 1200 V
Inert gas	Argon 10 sccm
Linear translation	Middle, intermediate, edge,
Tilt (parallel to the translation axis)	30 ° in each direction
Max. angular velocity	2.5 °/sec
Rotation (perpendicular axis)	30 ° in each direction
Max. angular velocity	5°/sec
Neutralizer	
RF power	50 W
Negative voltage	20 V
Inert gas	Argon 6 sccm

ETCHING RATE DISTRIBUTION





SURFACE ROUGHNESS OF MO THIN FILMS



Magnetron sputtering machine was used to deposit these Molybdenum fhin films.



- Secondary source was utilized. With the automation recipe, a homogeneous thickness distribution is to be found.
- AFM analysis proved the increase in Rq surface roughness for increasing Molybdenum thickness. This may be deposited with thick silicon and processed to achieve an improvement in Rq.
- A further investigation into the application of non-flat geometry samples may be considered in the future.