B_4C/Si based EUV multilayer mirror with suppressed reflectivity for CO_2 laser radiation

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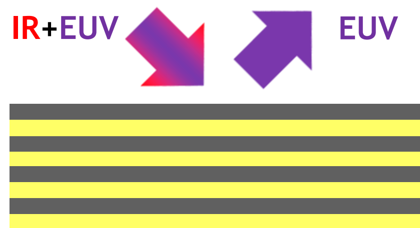
1. Introduction

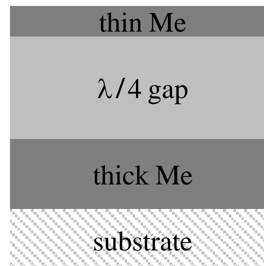
- LPP sources of EUV radiation produce large amount of scattered laser radiation
  - Spectral filtering is required
- Spectral purity filter can be integrated with existing EUV mirror



2. Working principle

Integration of EUV reflecting multilayer mirror with infrared (IR) anti-reflecting (AR) coating

- Resonant infrared absorber based on lossy Fabry-Perot ethalon



- Absorption coefficient of the system

$$A = \frac{4Z_0\sigma h}{(Z_0\sigma h+1)^2}$$

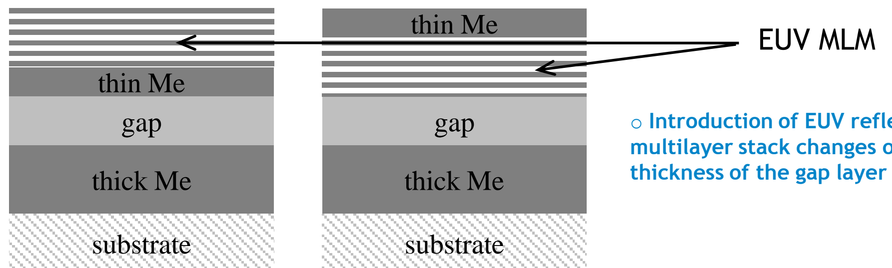
h – thickness of thin metal film
$\sigma(\lambda)$ – its conductivity
$Z_0 = 377$W – vacuum impedance

- 100% absorption can be achieved

$$h = (\sigma Z_0)^{-1}$$

$h \approx 1.5$ nm for Mo at 10.6 μm

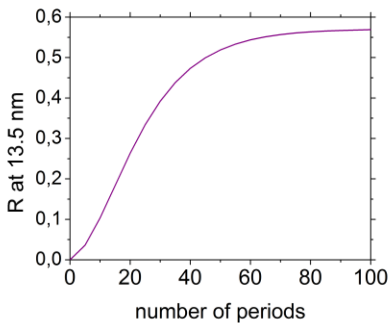
- Possible designs of itegrated mirror



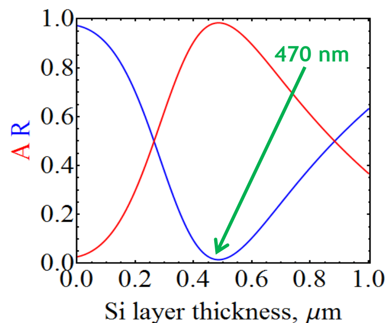
- Introduction of EUV reflecting multilayer stack changes optimal thickness of the gap layer

3. Numerical modeling

EUV reflectance modeling
- optimal period d=6.85 nm
- optimal ratio (B4C thickness)/period Γ=0.4



Optimization of Si gaplayer thickness for mirror with 60 periods of Si/B4C EUV reflecting stack on top of IR AR coating

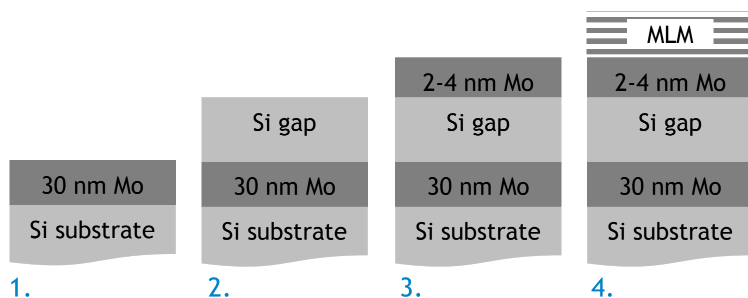


4. Experimental

Sample info:

- Magnetron sputtered:

1. 30 nm Mo - thick Me layer
2. ~470 nm Si – gap layer + ion polishing during deposition
3. 2-4 nm Mo – thin Me layer
4. 60 periods of Si/B_4C EUV MLM stack: d=6.85 nm, Γ=0.4

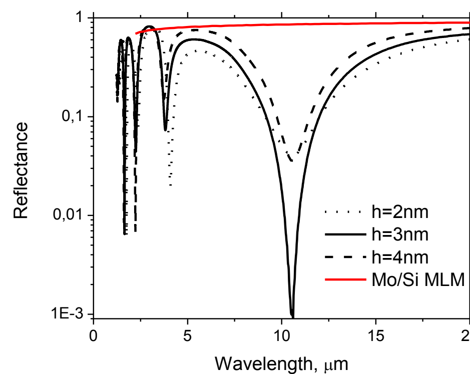


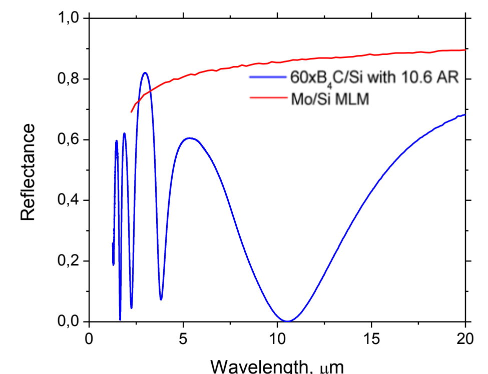
Optical measurements:

1. IR: Bruker IFS 66v/S FTIR spectrometer
2. EUV: soft X-ray beam line PTB (Berlin)
3. UV-VIS: Specord 200 spectrometer

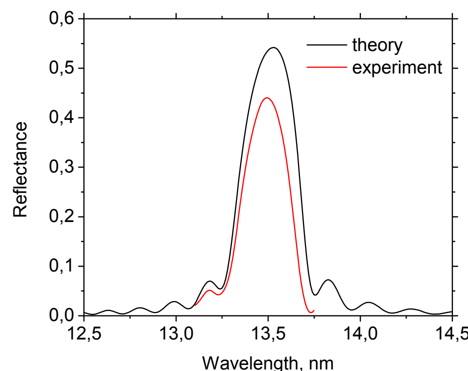
5. Experimental results

IR reflectivity

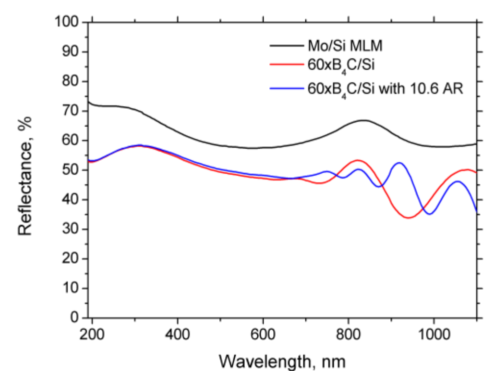




EUV reflectivity



UV-VIS reflectivity



6. Conclusions

- EUV multilayer mirror with near zero IR reflectance has been developed
- Suppression of IR radiation by up to 1000 times is demonstrated
- 45% of reflectivity at 13.5 nm is achieved

Acknowledgements

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