International Sematech, EUV Source Workshop
San Diego, November 10th, 2005

Ultra-thin films for SPF applications

Presented by L. Shmaenok
PhysTeX, Vaals, Netherlands

PhysTeX

Authors

N. Salashchenko, V.I. Luchin, A.Ya. Lopatin, N.N. Zybin
Institute for Physics of Microstructures,
Nizhny Novgorod, Russia

The work was initiated by V. Banine

Objectives

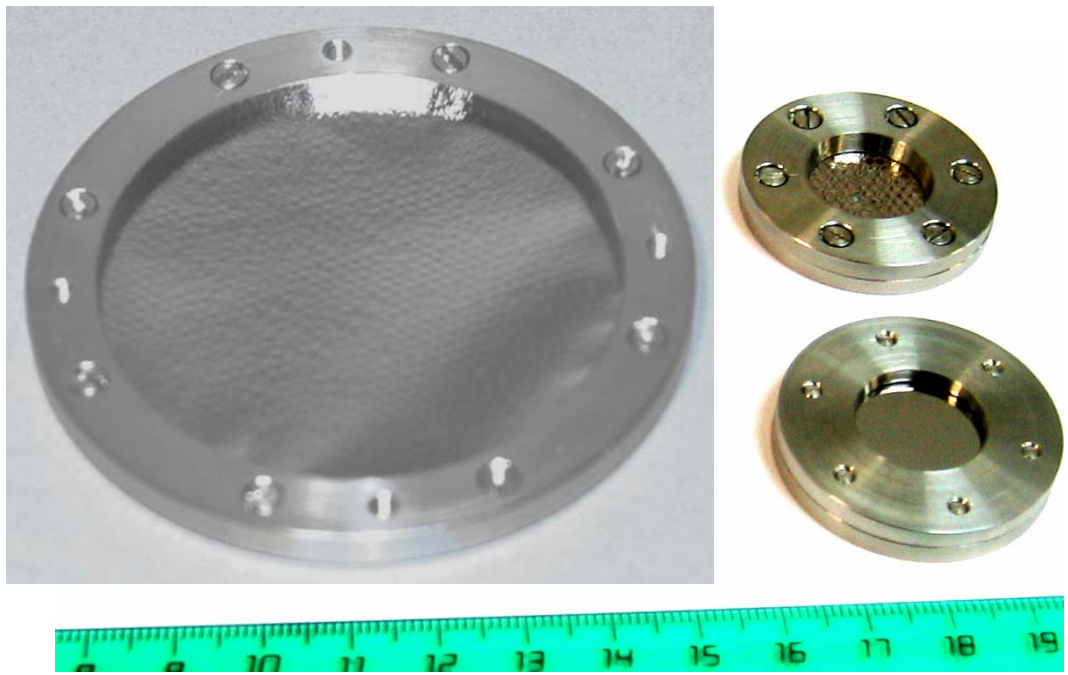
Development of transmission SPFs:

- Providing inband throughput of 80% and sufficient suppression of DUV, Vis and IR radiation
- Free-standing, defect-free, uniform, …
- Resistant to high power loads of >2 W/cm^2
- Resistant to specified pressure differentials
- Suitable for practical handling

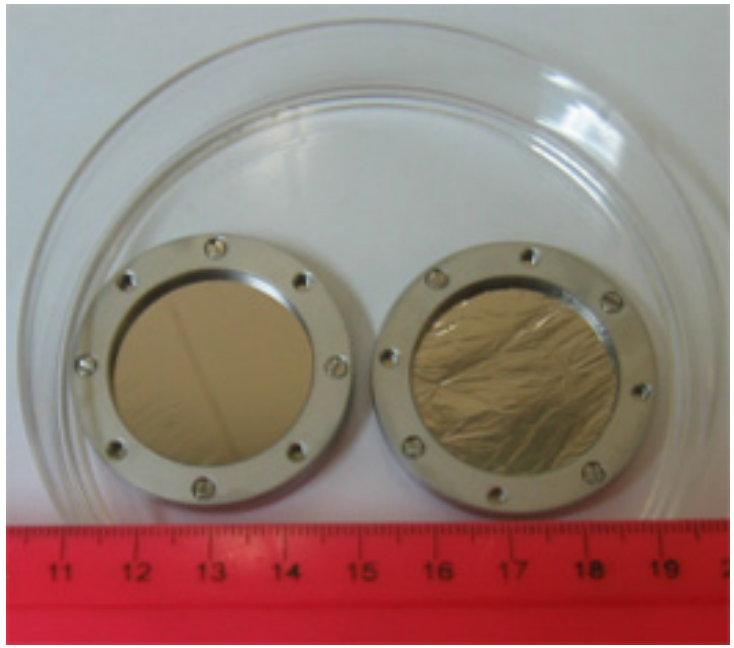
This work is a spin-off from development of transmisison filters for EUV diagnostics -

mesh-supported and free-standing filters, free from glue,

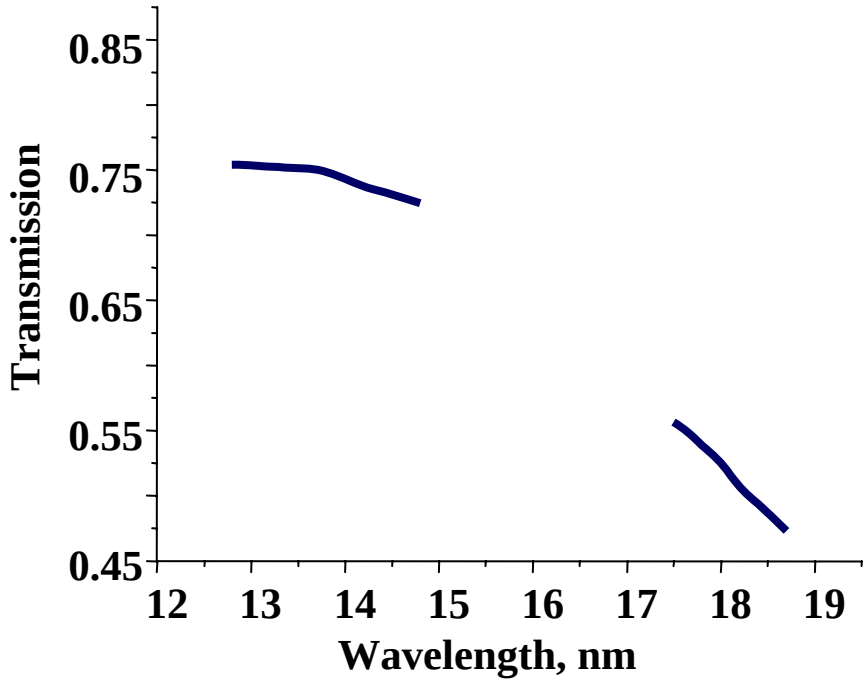
with inband throughput 40-50%, apertures up to 60 mm



Ultra-thin (< 60 nm) Zr-Si filters with 30 mm apertures - first steps to prototype SPFs

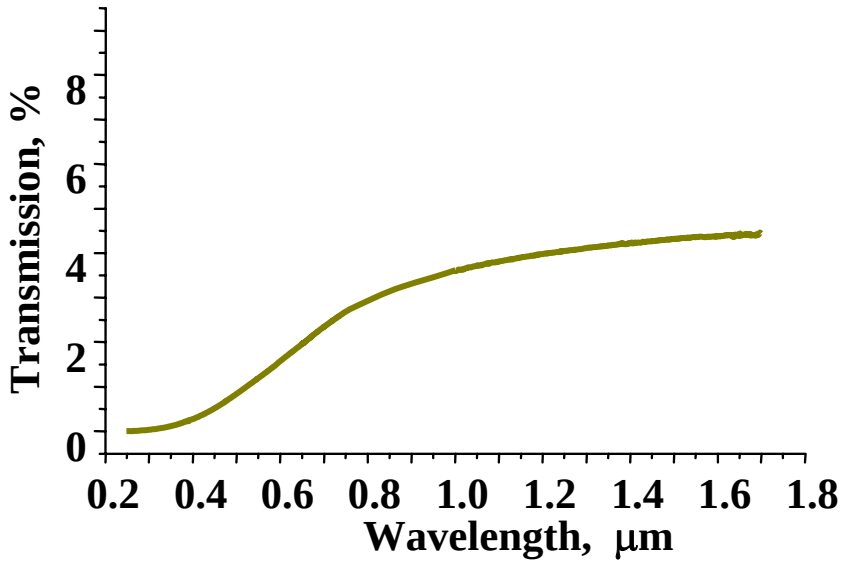


EUV spectral transmission



Measured transmission spectrum of a 55 nm ***Zr-Si*** filter

Out-of-EUV spectral transmission



Measured transmission spectrum of a 55 nm ***Zr-Si*** filter

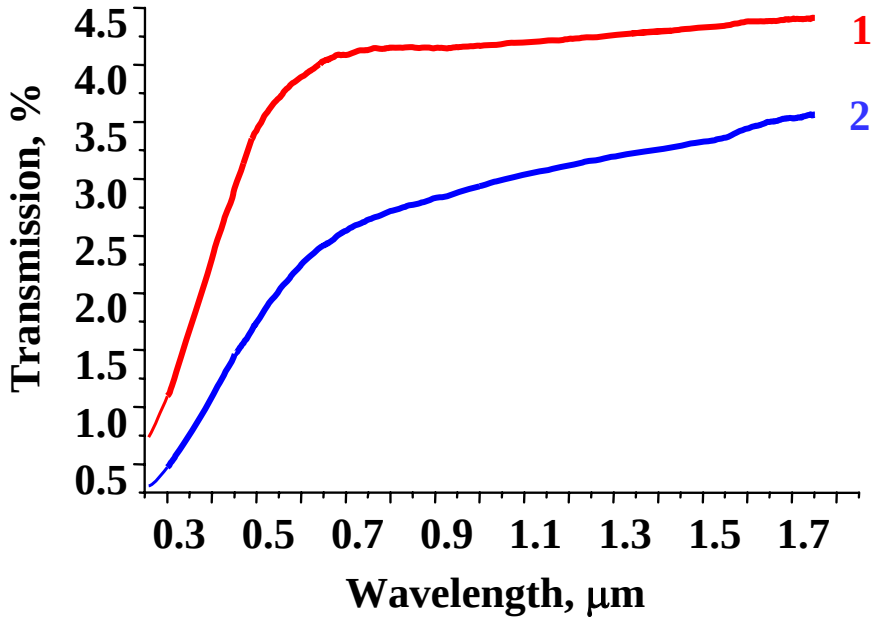
Resistance to pressure differentials (small samples of 50-60 nm films)

h, nm	*D*, mm	ΔP, bar
52	2.5	**0.34**
59	2.5	**0.23**

High power load exposures:

- Using a beam of low energy electrons
  at 1 W/cm^2 during 52 hours,
  up to 7 W/cm^2 in short time intervals
- With electron current through the film at
  3.5 W/cm^2 - in progress

Post-exposure spectral transmission



Measured transmission spectrum of a 55 nm ***Zr-Si*** filter in - (1) and out of (2) the zone irradiated at 1 W/cm² (*Ee*=1.6 keV) during 52 h

Inband transmission decreased from 77% to 73%

A preliminary microscopic analysis of irradiated samples has been performed

Practical handling, transportation

Summary of main results

- Free-standing SPFs with **30 mm** aperture, **50 nm** thickness, **78%** inband transmission, out-of-EUV transmission from **0.1%** (DUV) to **4%** (near IR)
- Durable tests of resistance to power loads of **1 W/cm^2** (e-beam) and **3.5 W/cm^2** (e-current)
- Spectral and microscopic pre- and post-exposure analysis, interpretaion of transmisison changes (**78% → 73%**, some clearing-up in OoEUV range)
- Reliable basis for further optimization

Acknowledgment

The work is now additionally supported by EC Commission