



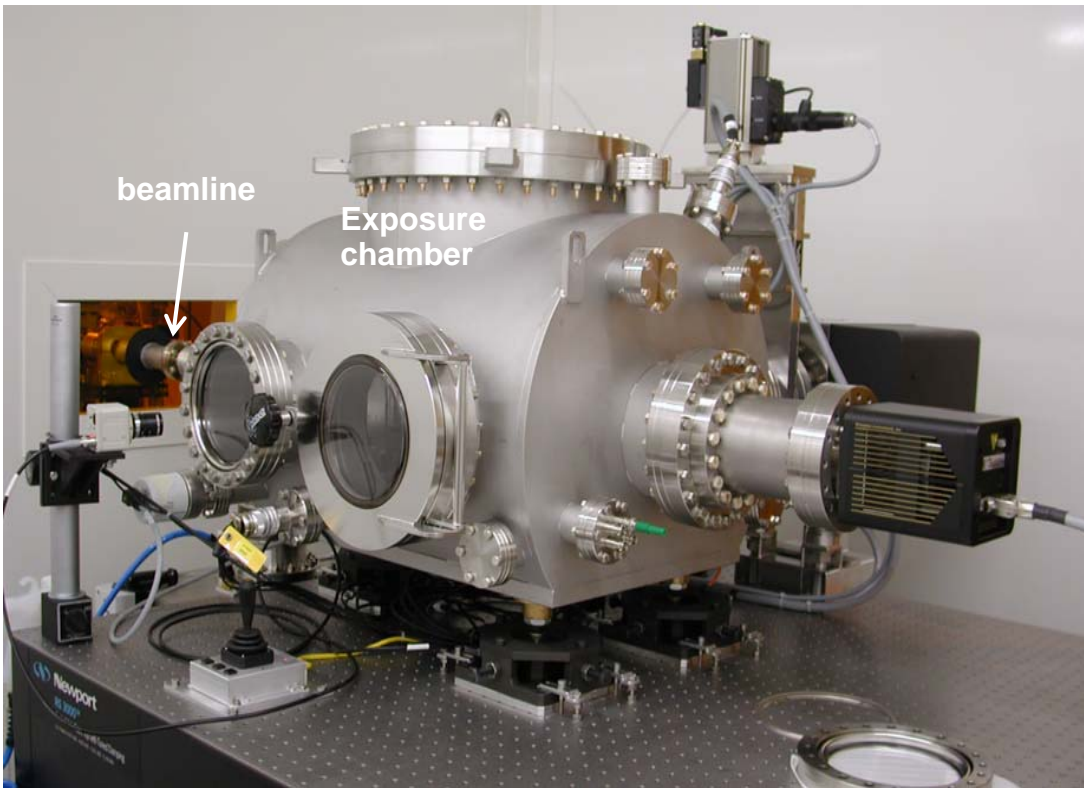
# EUV Interference Lithography at PSI

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# EUV-IL Exposure System

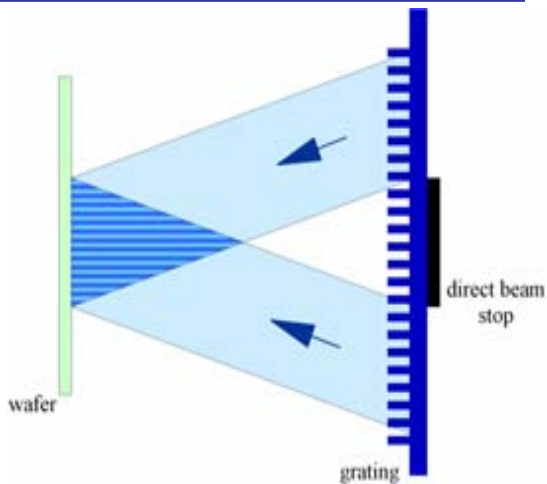


- Class 1000 cleanroom
- Chemically filtered air (amines)
- Sample stage for 4 – 8” wafers
- Stage travel range 80x80 mm
- PEB next to exposure tool
- Sample-coating/development in separate cleanroom
- NO outgassing requirement
- Throughput: ~1 wafer/hour (50-100 doses)
- Constant beam current at SLS (top-up), stable and constant illumination
- Illumination flux measured before exposure monitored afterwards

# The Interferometer

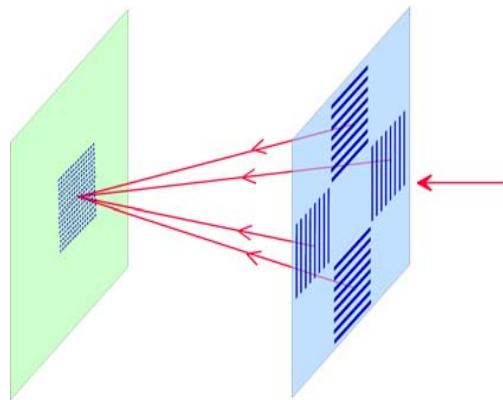
- Based on transmission diffraction gratings patterned on SiN membranes
- Diffraction gratings made in-house with e-beam lithography or EUV-IL
- No alignment – no focus → same image each time
- High-contrast as deduced from resist performance

## 2-Beam Interference



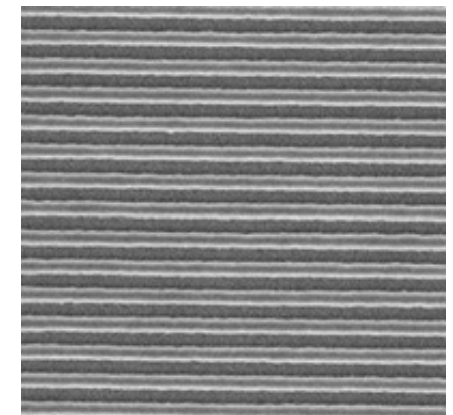
- Line/space patterns

## 4-Beam Interference



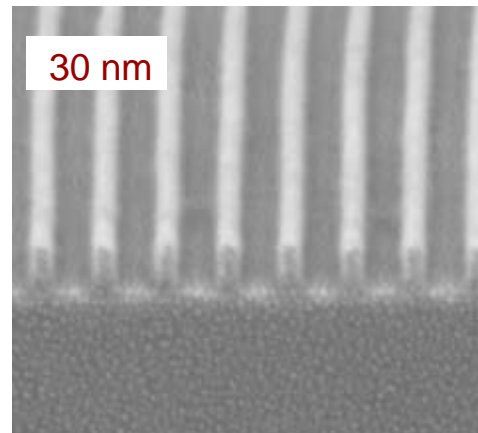
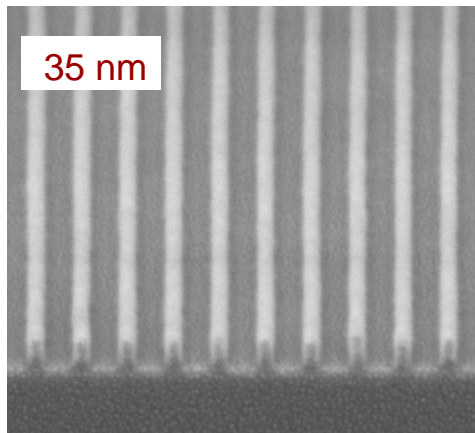
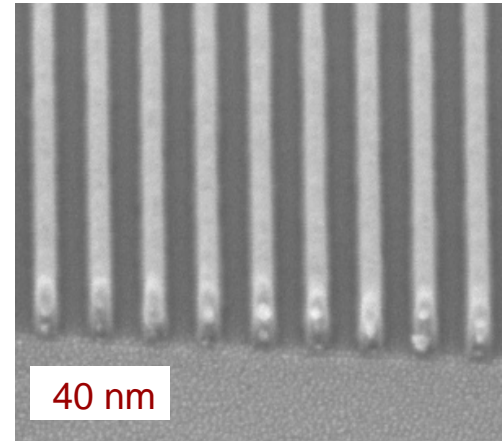
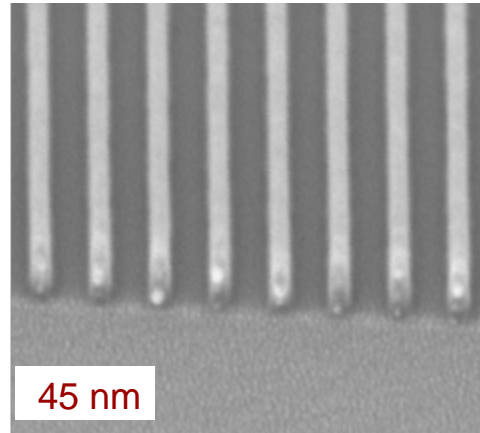
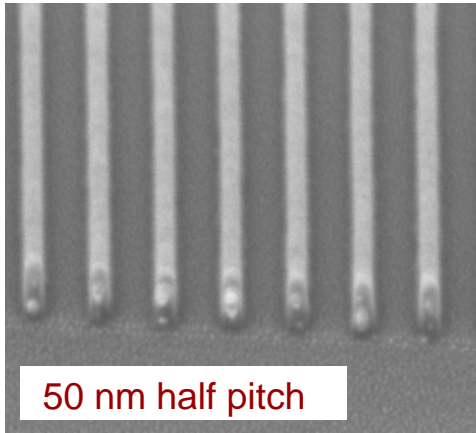
- Square hole array

## Diffraction Gratings



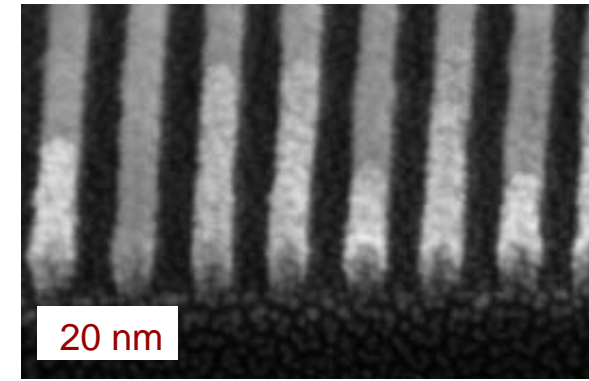
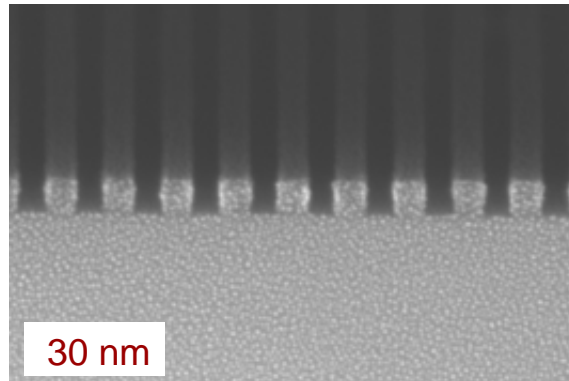
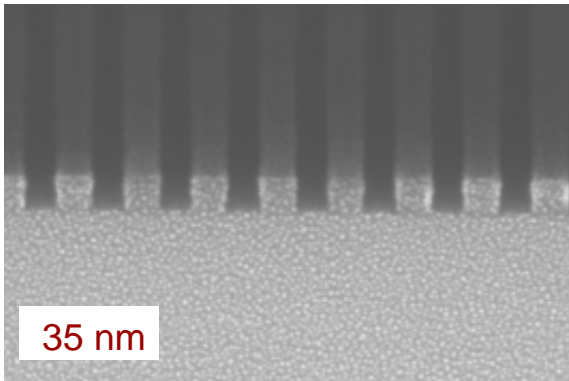
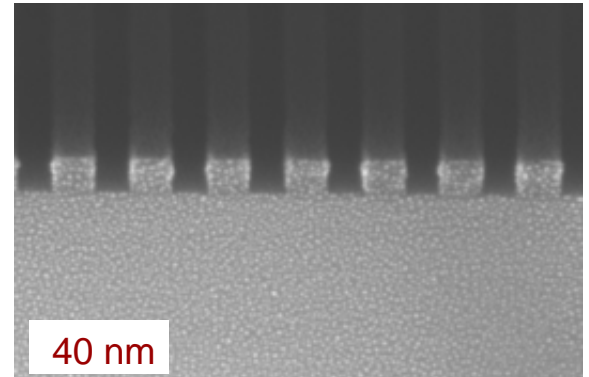
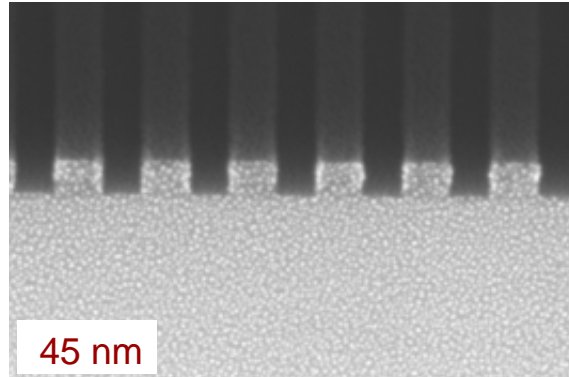
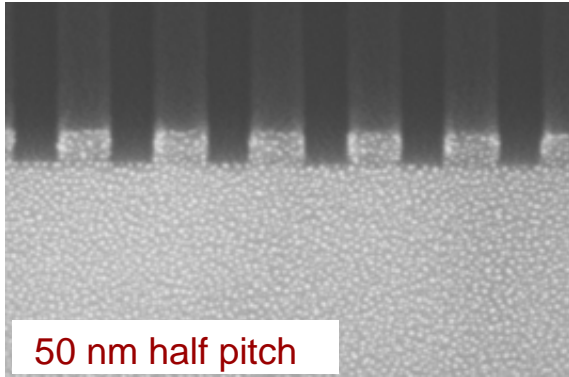
100 nm L/S mask

# EUVIL Test Results with PMMA

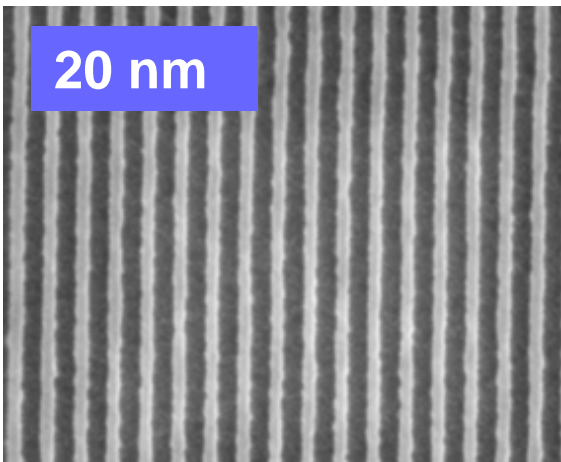




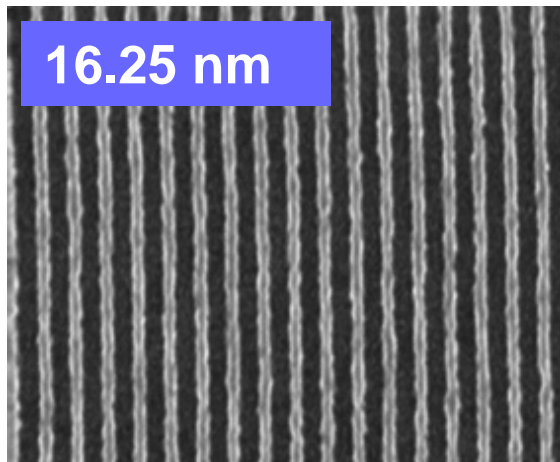
# EUVIL Test Results with HSQ



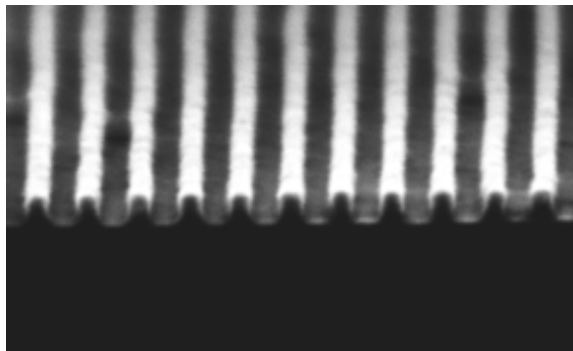
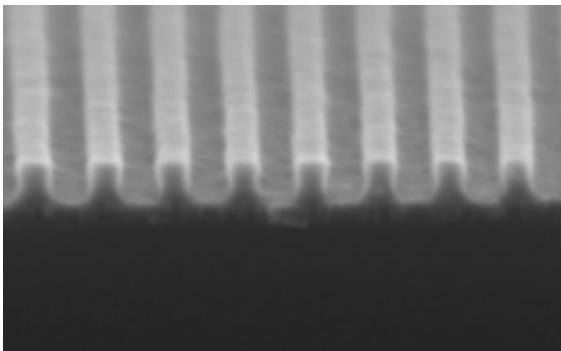
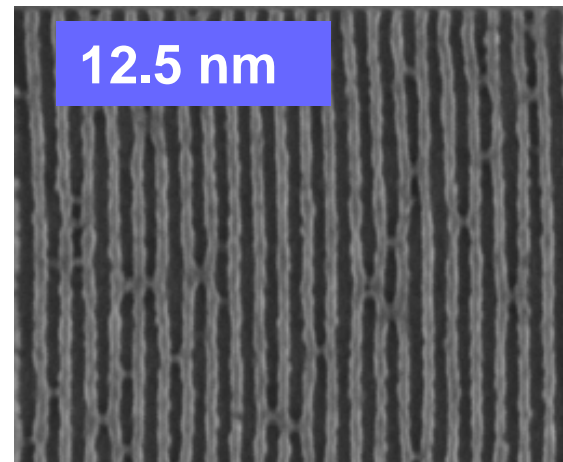
20 nm



16.25 nm



12.5 nm



**TEBN-1 Tokuyama Co**

**Film thickness: 20-30 nm**

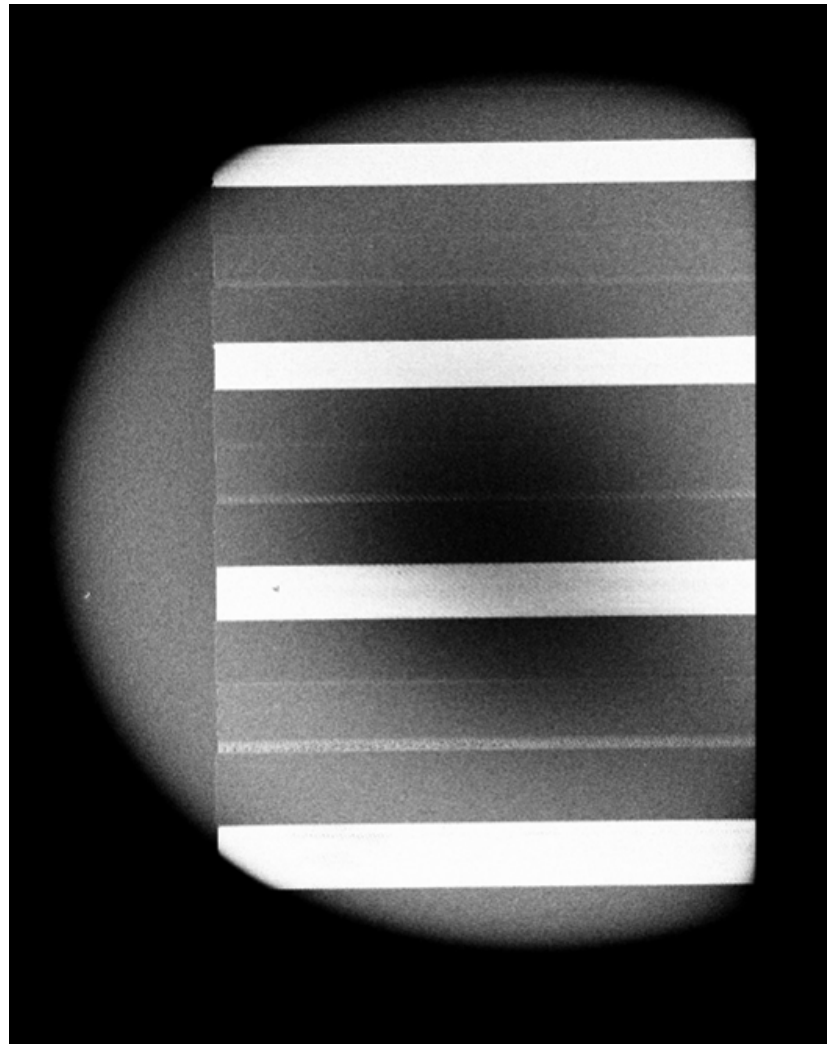
**Development: IPA, 30 s**

# Mask Layout



- 25-50 nm L/S printed simultaneously
- 800  $\mu\text{m}$  long cleavable lines
- Pattern width: 50-100  $\mu\text{m}$

# Pattern on Wafer



45 nm

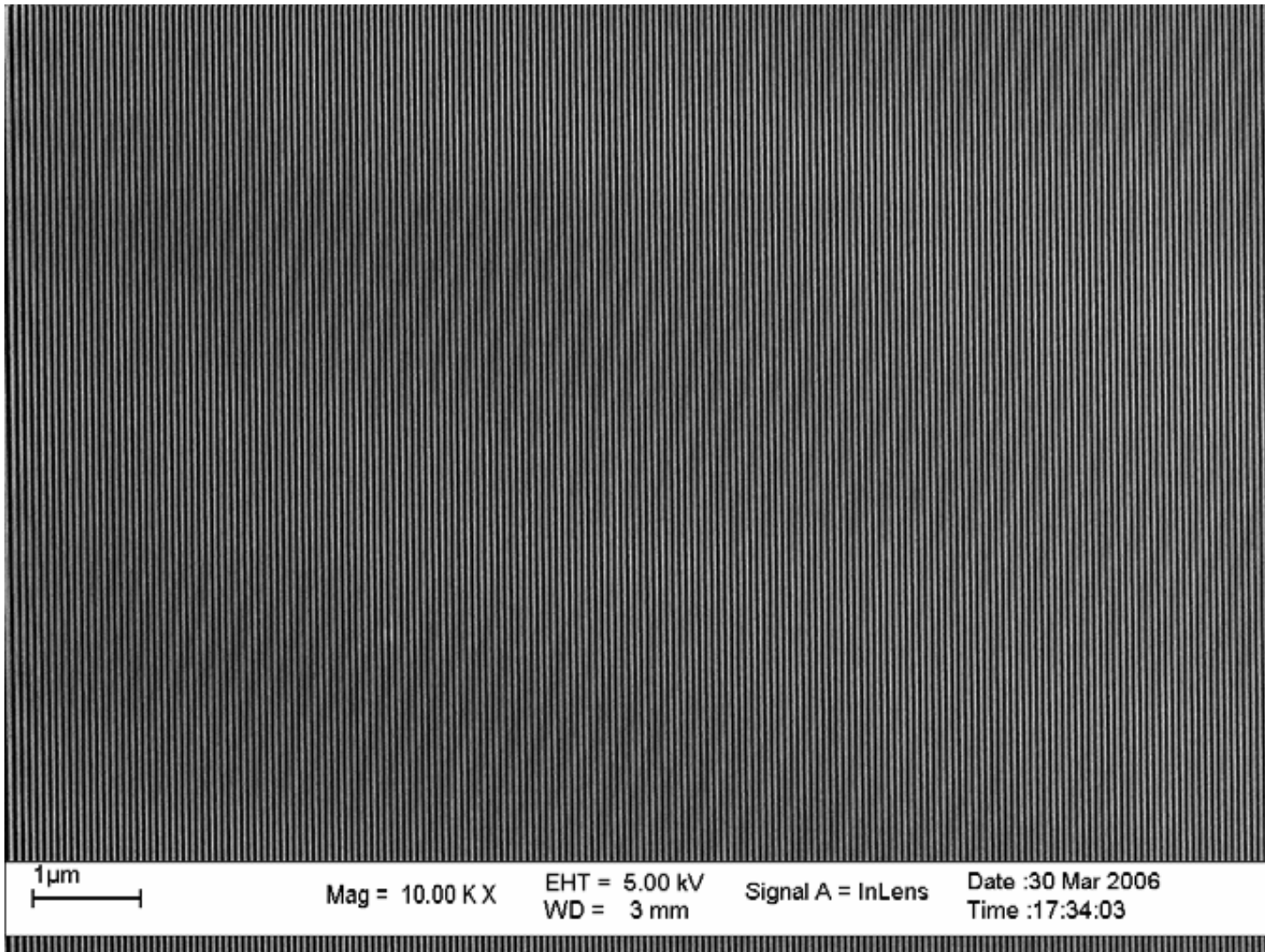
40 nm

35 nm

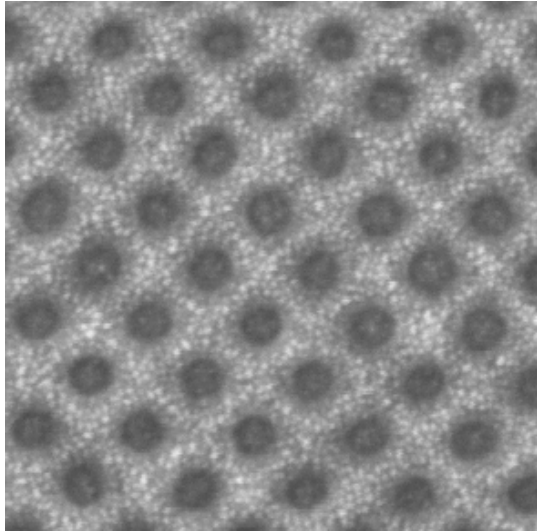
30 nm

Low magnification SEM image of pattern in HSQ

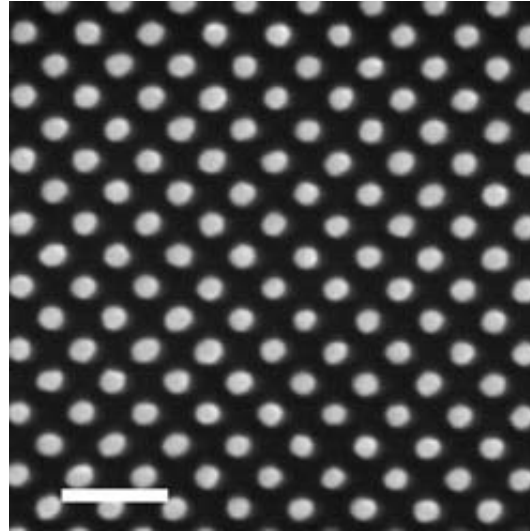
# EUVIL Test Results with HSQ



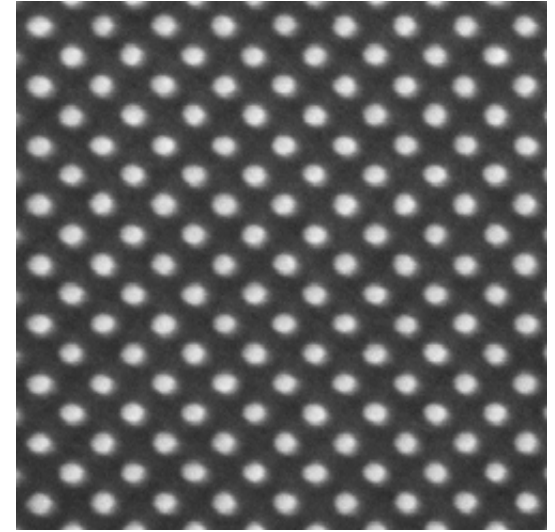
- Low-magnification image of 30 nm L/S pattern



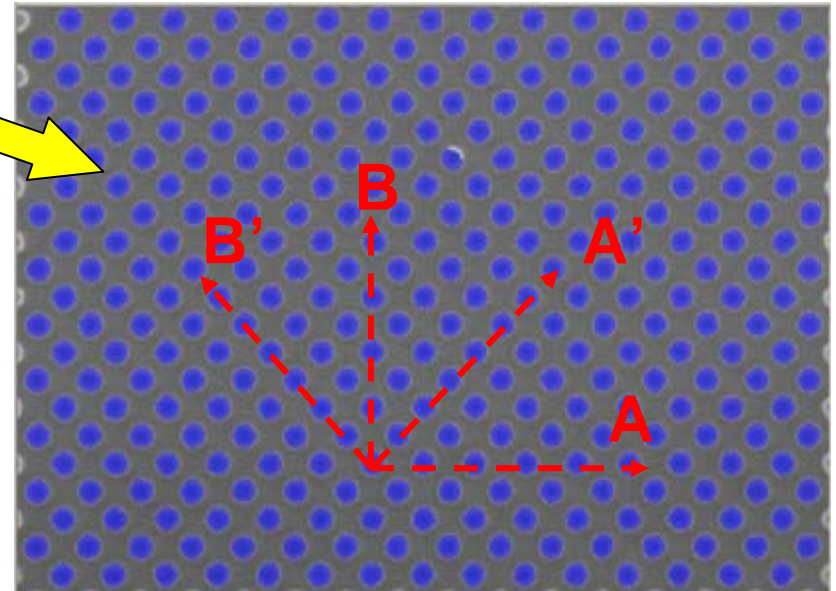
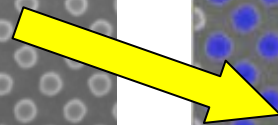
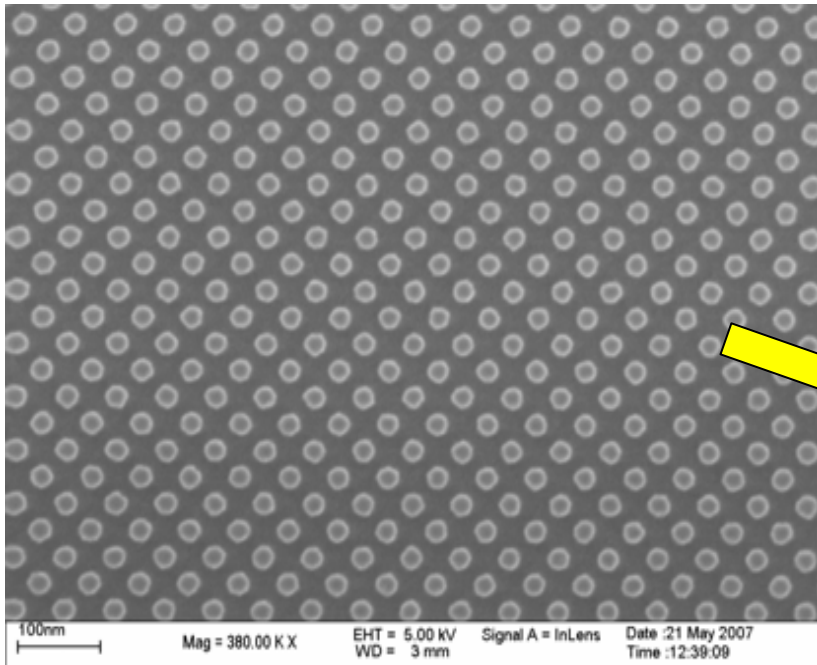
24.7 nm HP - PMMA



21.2 nm HP - HSQ



17.1 nm HP - HSQ

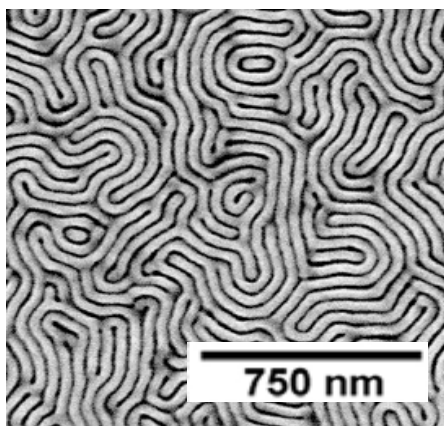


	average (nm)	stdev (1 sigma, nm)	stdev/average
direction A, dot-to-dot distance	59.9	0.5	0.9%
direction B, dot-to-dot distance	59.9	0.5	0.8%
direction A', dot-to-dot distance	42.7	0.6	1.4%
direction B', dot-to-dot distance	42.0	0.5	1.3%
dot size in plane	25.8	0.4	1.7%

Analysis by Justin Hu, Kim Y. Lee, David Kuo, Dieter Weller, Seagate Technology

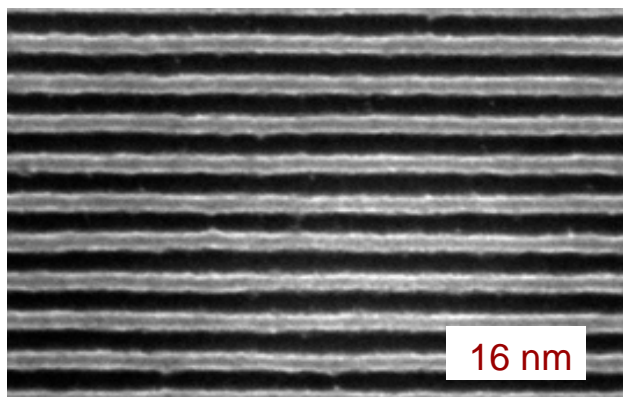
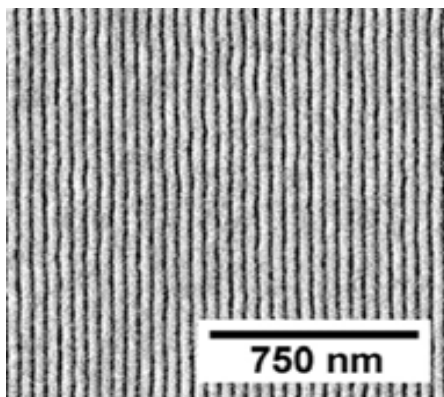
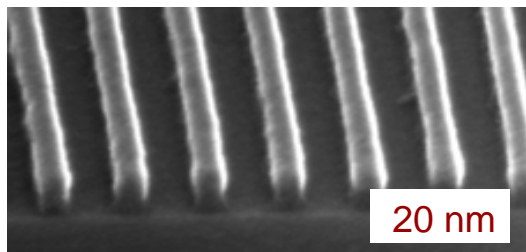
Block-copolymers

P. Nealey, UW



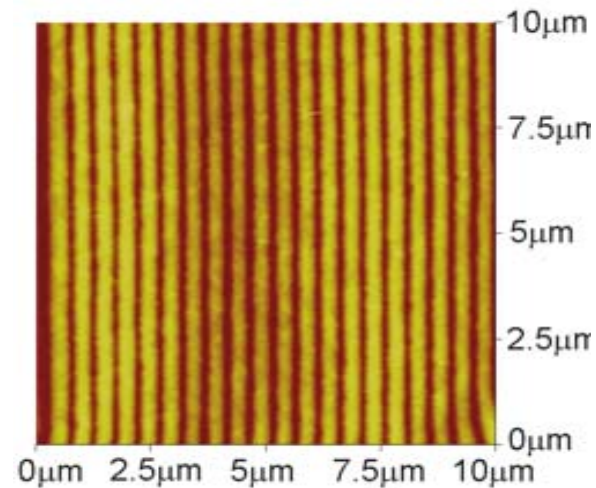
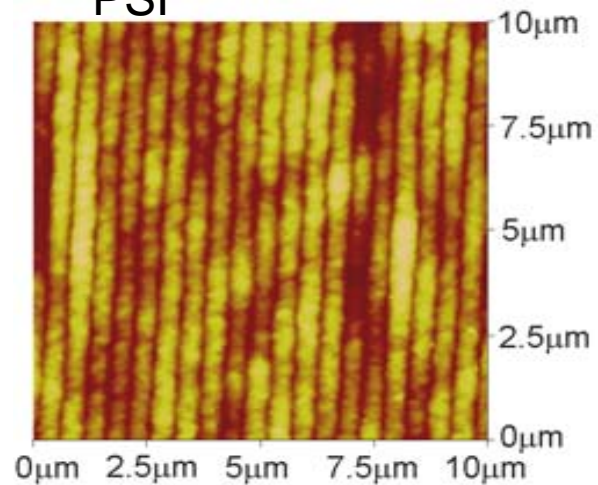
ZnO

PSI



Nano-grafting

PSI



- Limited number of shifts are available
- Resist receiving, storage, coating, exposure. development, shipping  
~ USD 6500 /shift
- State of the art SEM available for top-down imaging (fee)
- Schedule made for 6-month periods (Jan-Jun, Jul-Dec)
- Contact: [harun.solak@psi.ch](mailto:harun.solak@psi.ch)



# Next Generation EUV-IL at PSI

- Full-time beamline with undulator source under construction
- Capacity increase 6x
- Processing equipment (coating, development) near exposure tool
- Completion in 2009
- Open for long-term contracts and shift access (outgassing?)