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# Evaluation of resists for sub-22 nm hp patterning using EUV interference lithography


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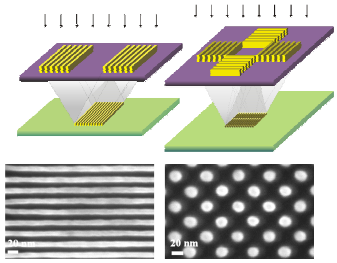
## Motivation & Introduction

- The performance of EUV resists is a key factor for the cost-effective introduction of EUVL.
- While most of the global effort concentrates on resist performance for ≤ 22 nm hp, it is crucial for the future of EUVL to show its extendibility towards future technology nodes
- We present RLS performance (CD, LER, dose) of a chemically-amplified resist and inorganic resists for feature sizes ranging from 30 nm hp to 6 nm hp.
- EUV-IL is a powerful tool for the evaluation of resist performance for future technology nodes, helping to fill the time gap until higher-NA alpha tools become available.

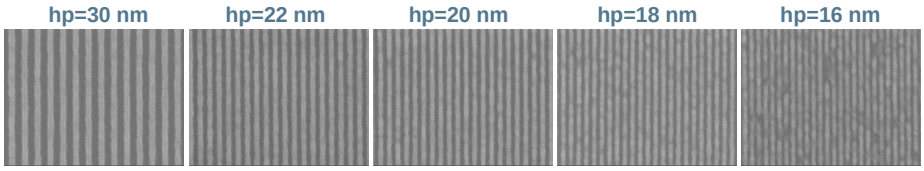



11 nm lines and 19 nm dots

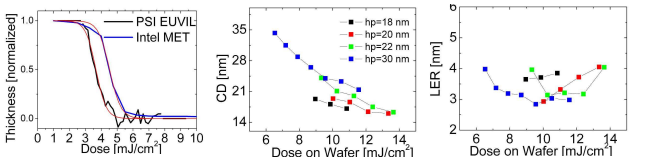
## EUV Interference Lithography @ PSI

- Stable light source: undulator (synchrotron)
- Coherent illumination
- Variable wavelength: 16 nm to 3 nm
- Diffractive transmission gratings
- Well-defined areal image: pitch independent sinusoidal image
- High resolution: modulation down to 6 nm
- Stable interferometer
- Infinite depth of focus
- Large area: for cross-sectional analysis
- Excellent reproducibility
- On-site pre/post-processing in cleanroom

## Performance of a Chemically Amplified Resist




**SEVR-140**
Thickness = 35 nm
PEB: 100 ℃ / 60s
PAB: 95 ℃ / 60s
DEV: 2.38% TMAH / 30s



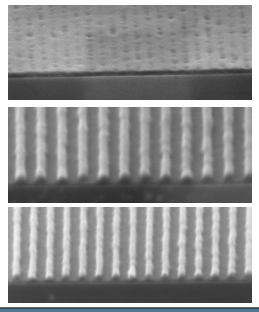

(*) *For dose-on-wafer, dose-to-clear calibration curve was matched to Intel's MET.*

- Good performance down to 18 nm
- High LER for 16 nm:
- Collapse problems for 16 nm
  - ⇨ Reduce the resist thickness?

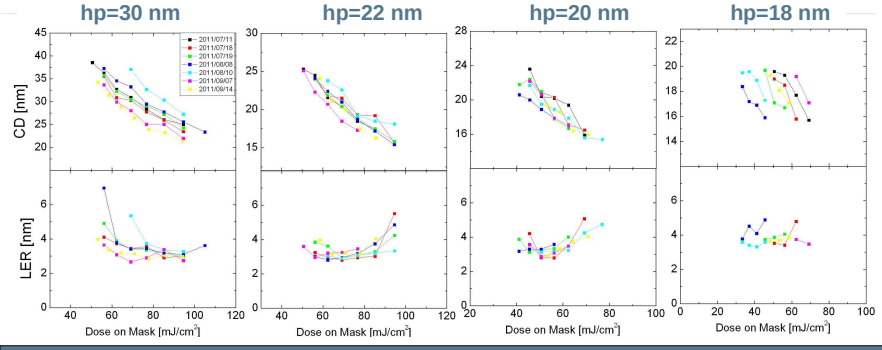
Cross-sectional analysis:

- Small LW is correlated with top-loss
- LER has significant contribution from resist footing

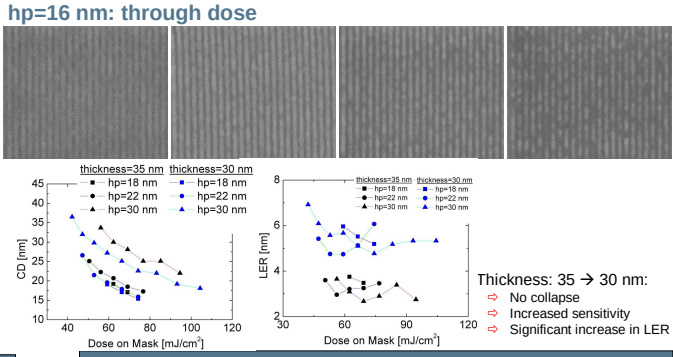
Cross-sections: hp=30 nm



## Reproducibility study over 3 months

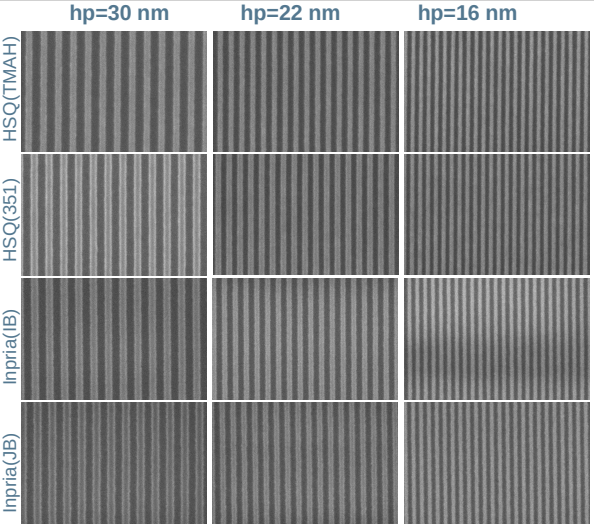



## Thinner Resist for hp = 16 nm



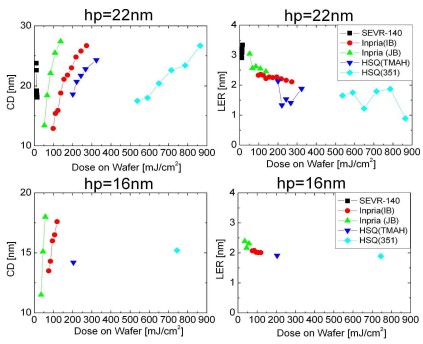

Thickness: 35 → 30 nm:
- ⇨ No collapse
- ⇨ Increased sensitivity
- ⇨ Significant increase in LER

## Comparative Study of CAR and non-CARs

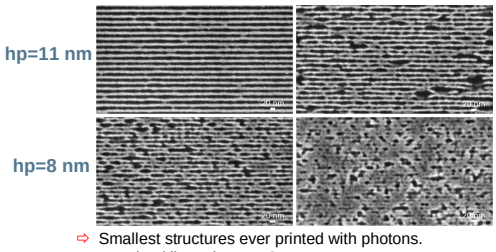



Sensitivity @ 22nm:

| | |
|---|---|
| SEVR-140 | 11.3 mJ/cm² |
| Inpria(JB) | 85.9 mJ/cm² |
| Inpria(IB) | 175 mJ/cm² |
| HSQ(TMAH) | 246 mJ/cm² |
| HSQ(351) | 709 mJ/cm² |

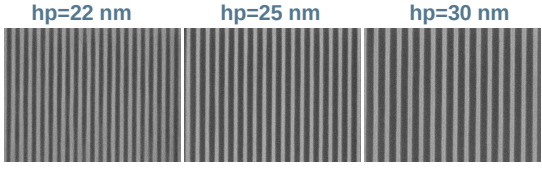



## Towards sub-10 nm resolution




- ⇨ Smallest structures ever printed with photons.
- ⇨ Resolved lines down to 9 nm.
- ⇨ Modulation down to 6 nm
- ⇨ Significant adhesion and collapse problems in sub-10 nm hp

## IL @ λ=6.5 nm (soft X-Ray or hard EUV)





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