PiBond

Role of Materials for Semiconductor Manufacturing Enabling Future Nano-optical Applications and Devices

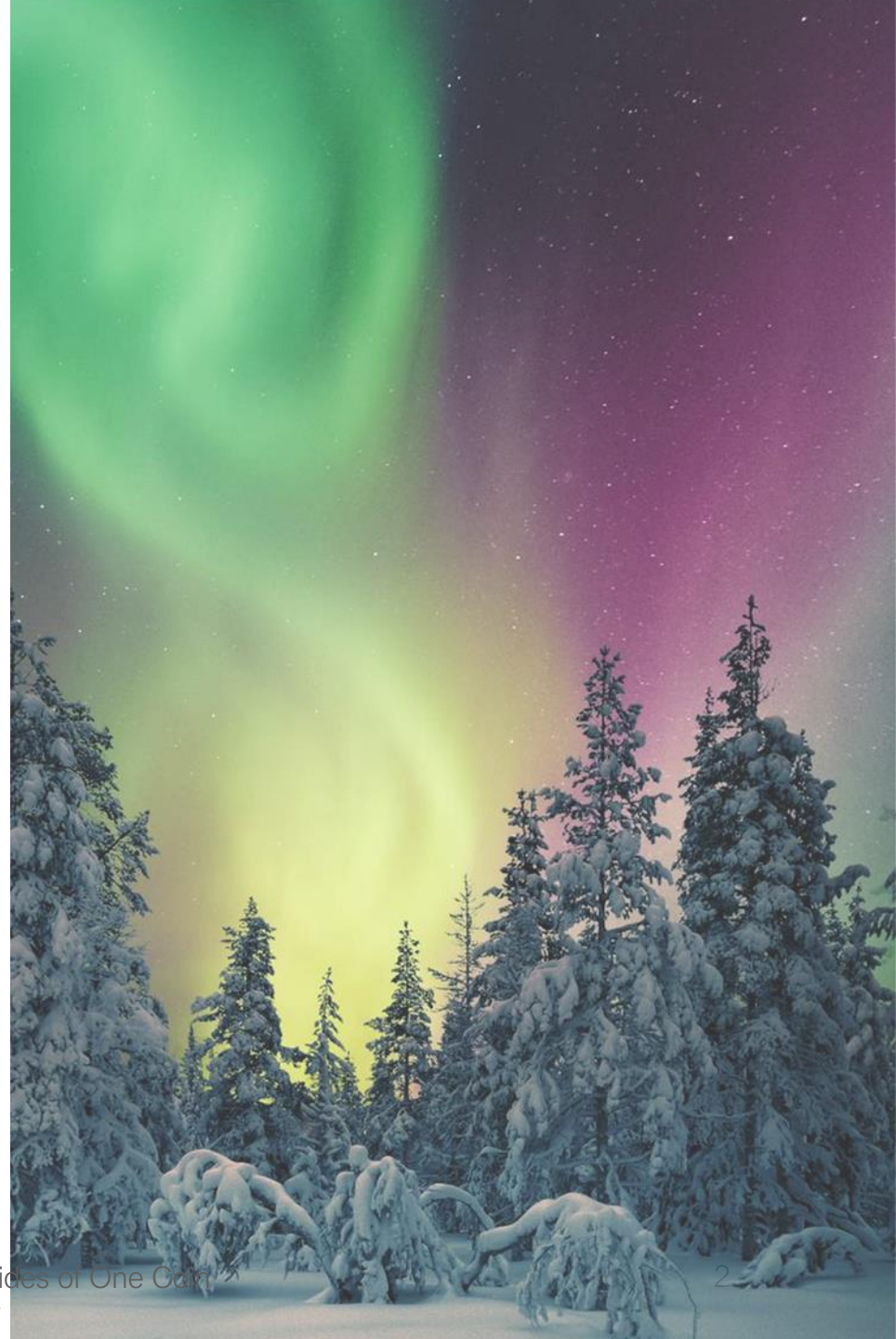
Thomas Gädda, CTO

Who we are

We are an innovative materials company with strong R&D capabilities and a portfolio of unique patents. We are one of the only European suppliers of EUV lithography materials. Pibond's materials have been adopted in the latest semiconductor devices globally.

Our Experienced global management team includes industry veterans from some of the largest Semiconductor chip and device companies.

We have an audited supplier track record to the semiconductor industry from our 3000 square meter PPT *(parts per trillion)* Clean Room production facility in Finland.



RESPONSIBLE CARE® OUR COMMITMENT TO SUSTAINABILITY

MANAGEMENT SYSTEM CERTIFICATION DNV·GL ISO 9001 = ISO 14001

PiBond

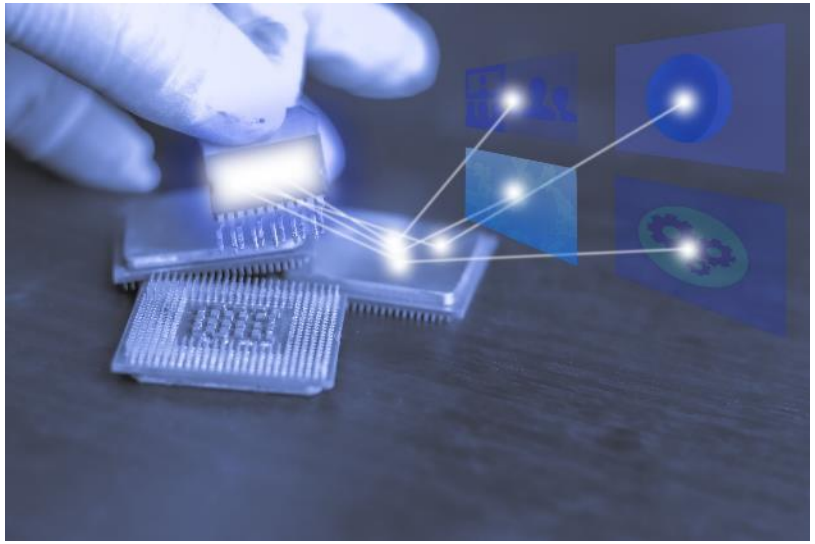
PiBond is a leading innovator of Advanced Materials

PRESENT

Semiconductor Dielectrics
for State-of-the-Art Applications

Optical Coatings for
Image Sensors

Enabling Layers for
Sub-5nm microelectronics

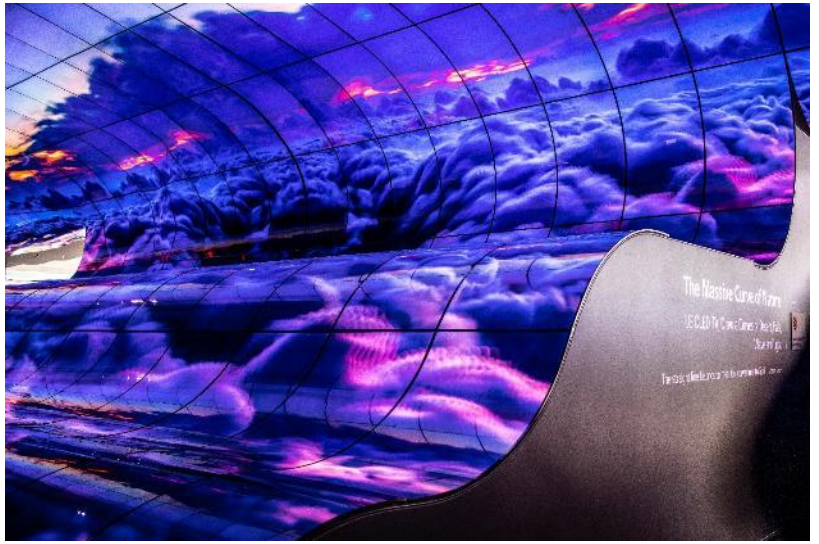


FUTURE

Future Data Transfer
Through Photonics

Semiconductor-level
Precision and Reliability
to Photonic Applications

Devices and components
enabled by novel processes



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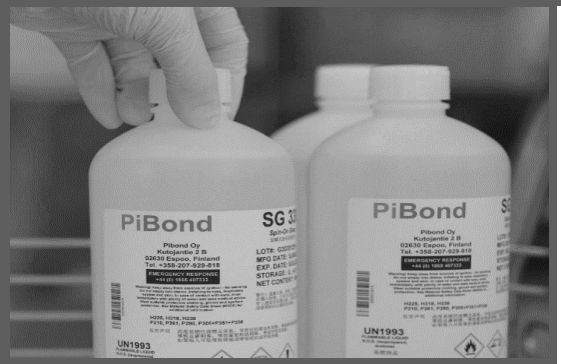
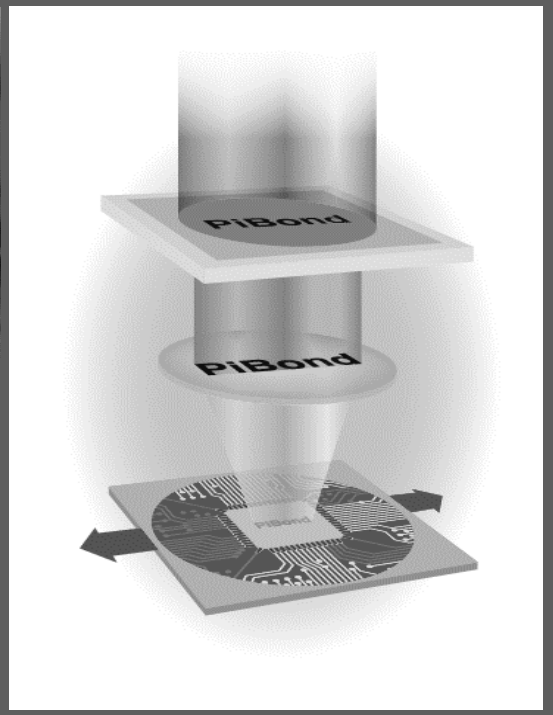
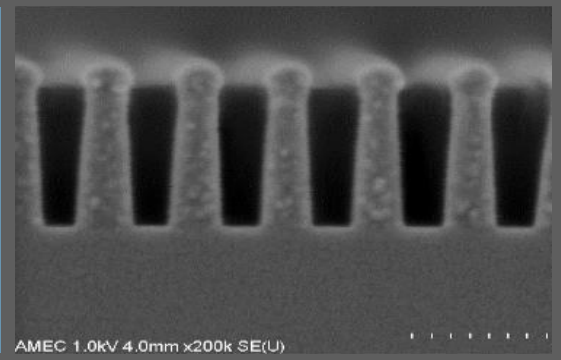
Advanced Lithography

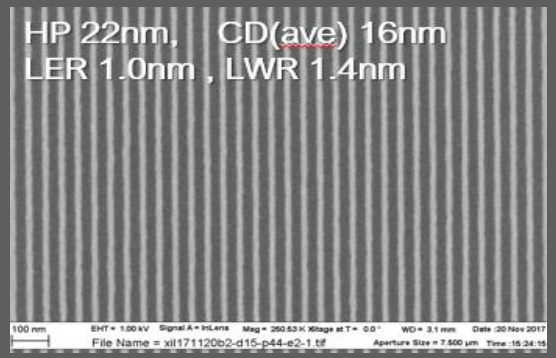


Demand for
Inorganic solutions



Industry proven
stack <**5nm**





Leading Etch
selectivity for future
devices

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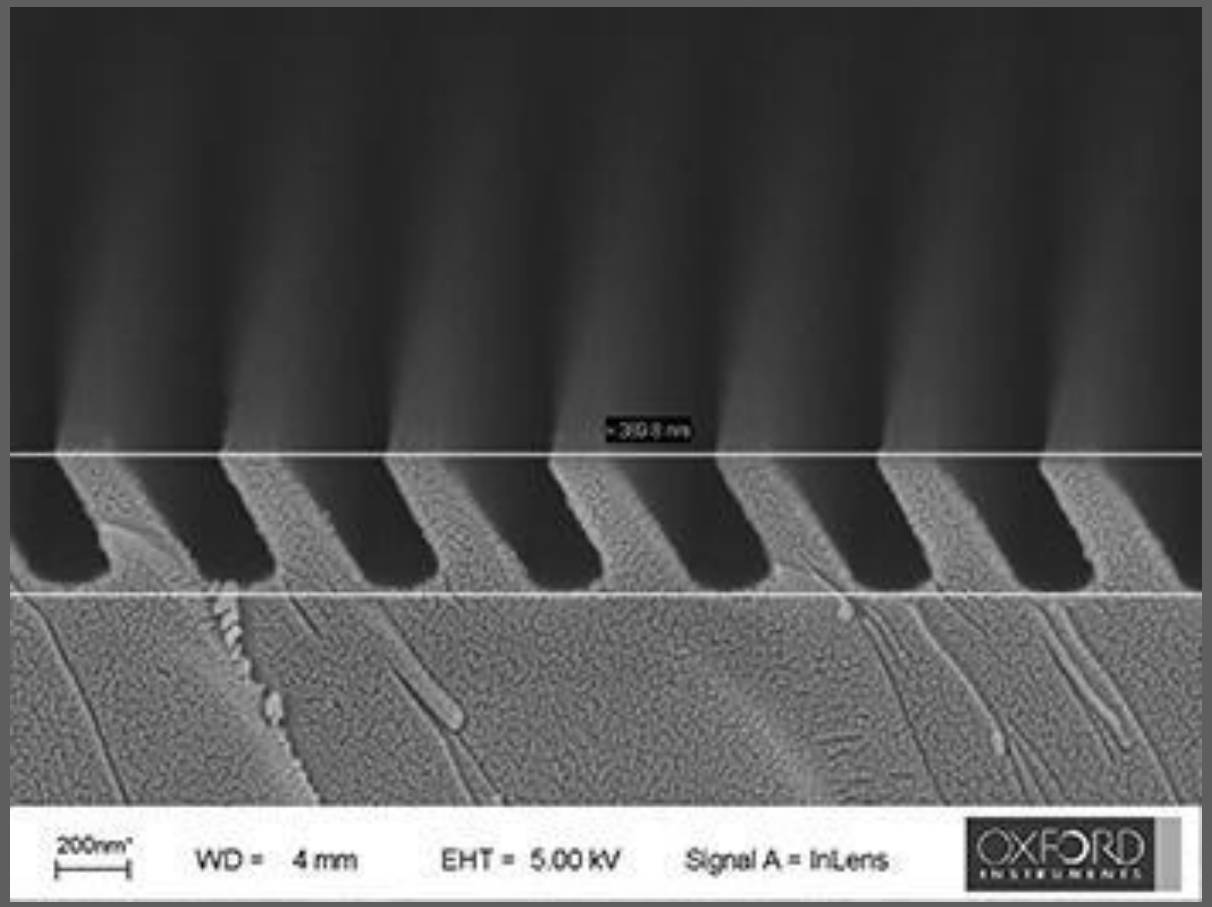
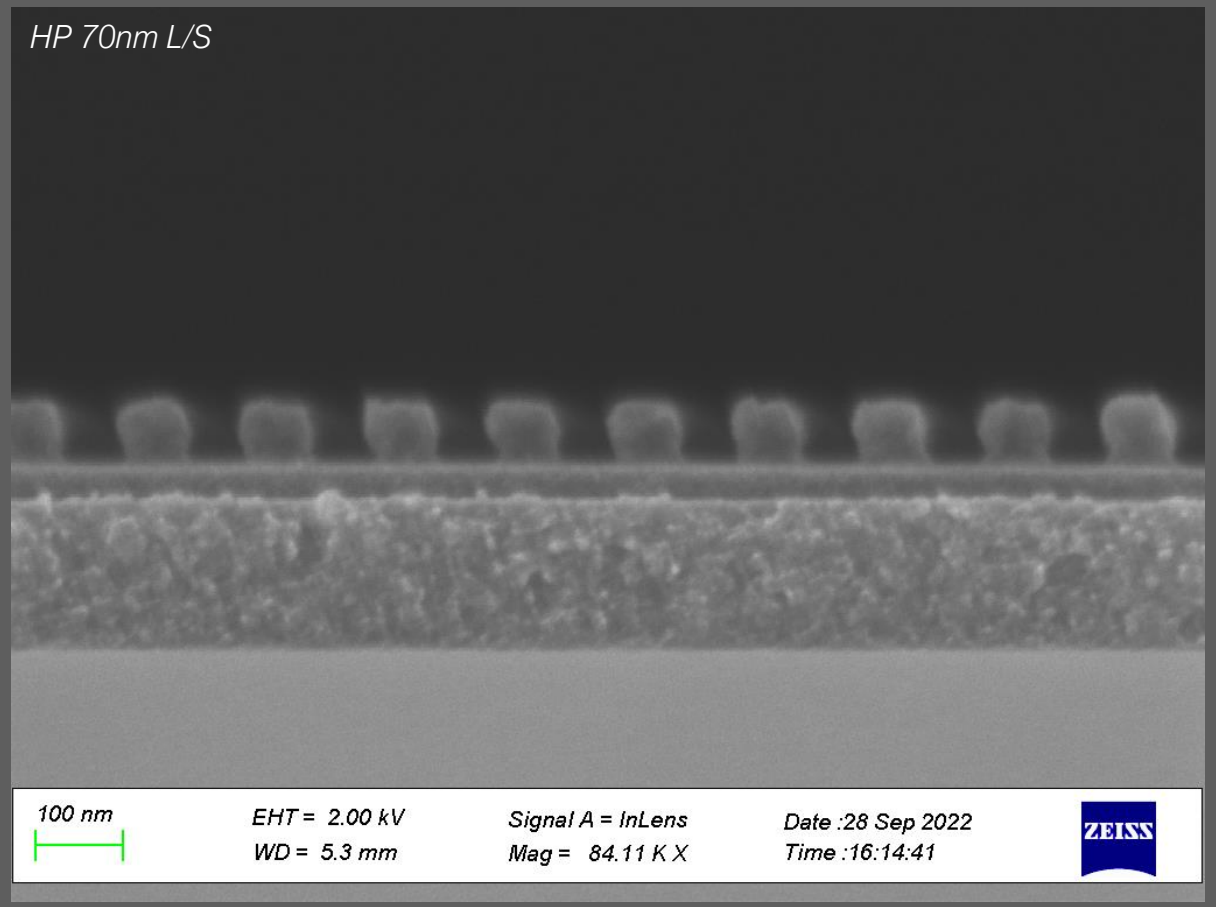
Advanced Lithography Materials for line patterning



https://plasma.oxinst.com/blog/2020/3-steps-for-surface-relief-gratings



Photolithography etch hard masks

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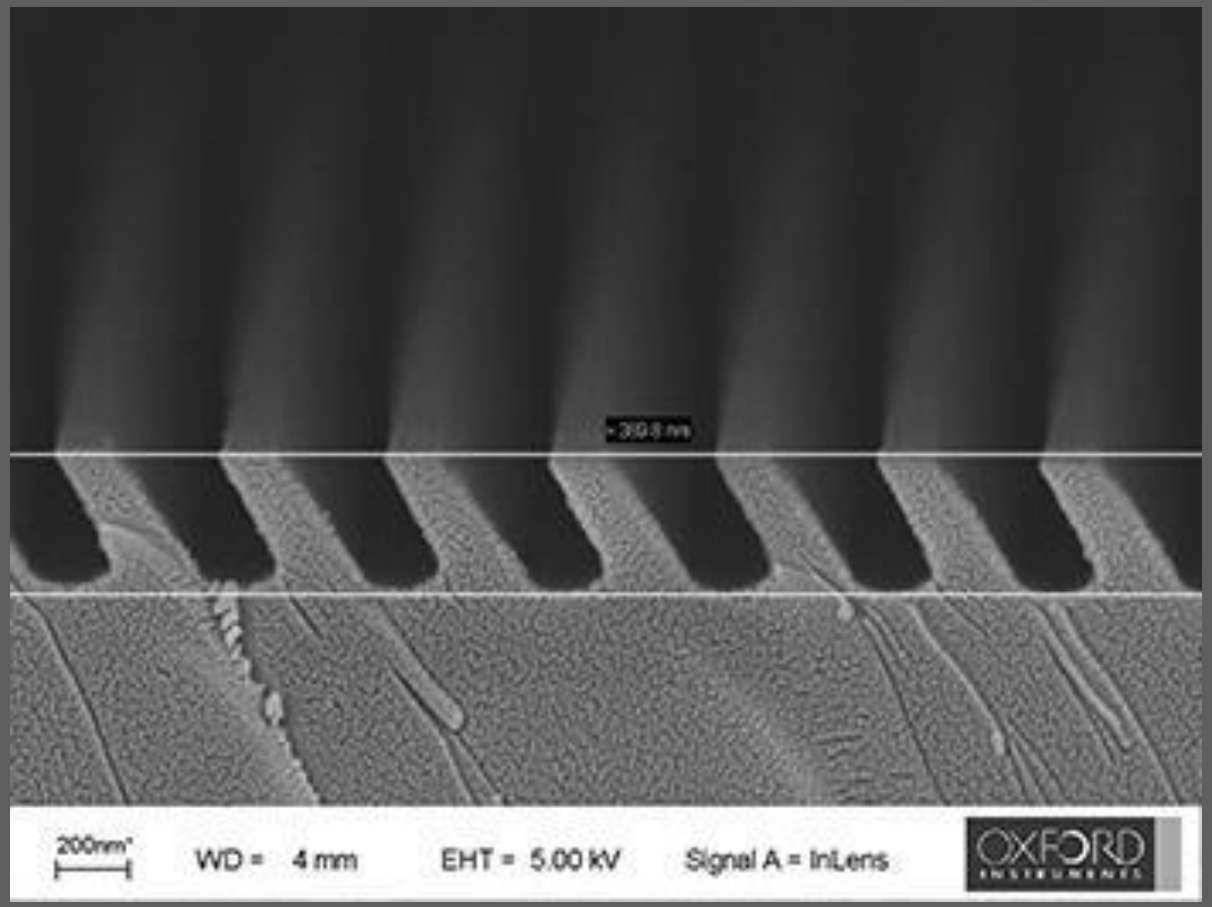
Advanced Lithography Materials for line patterning



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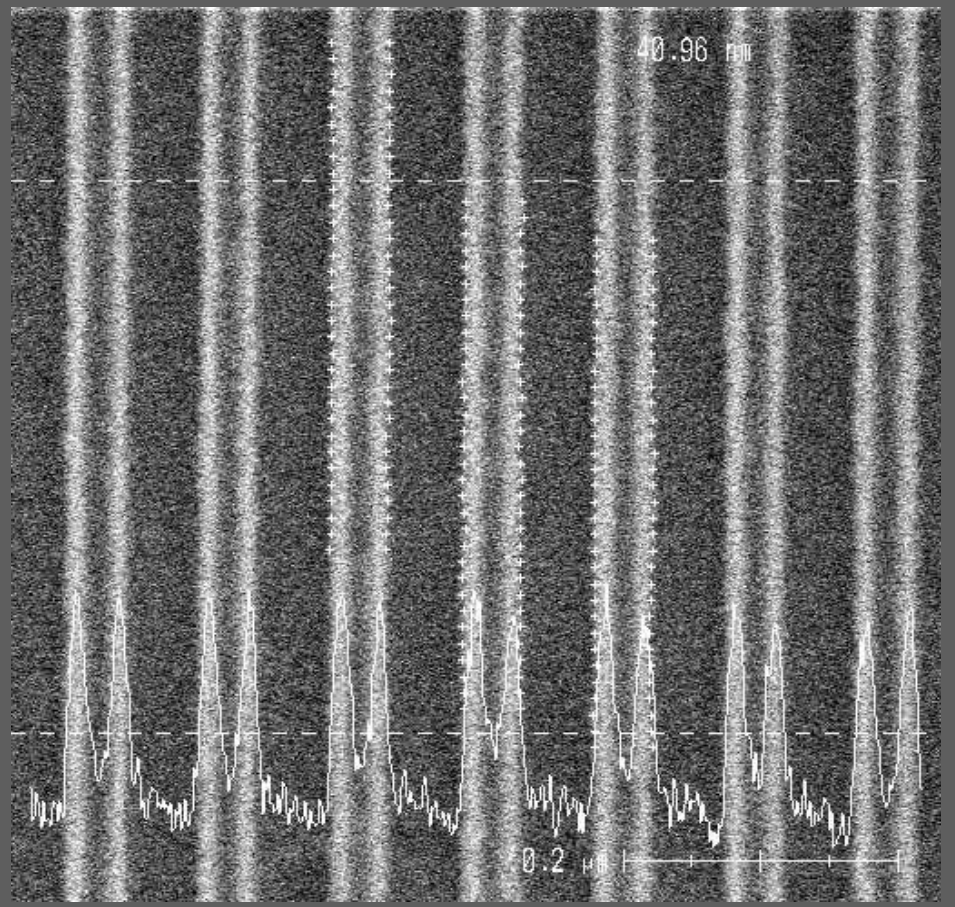

Silicon hard mask materials for advanced lithography

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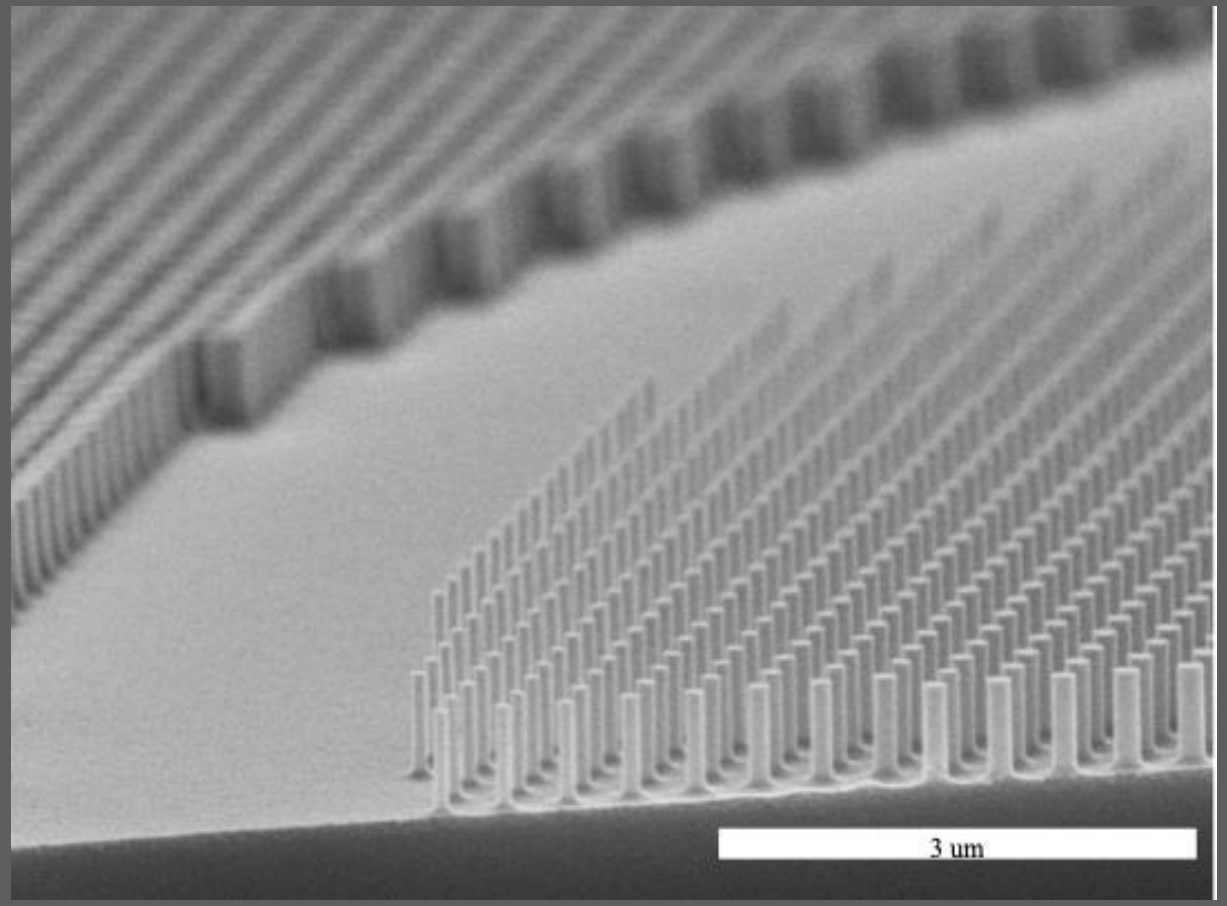
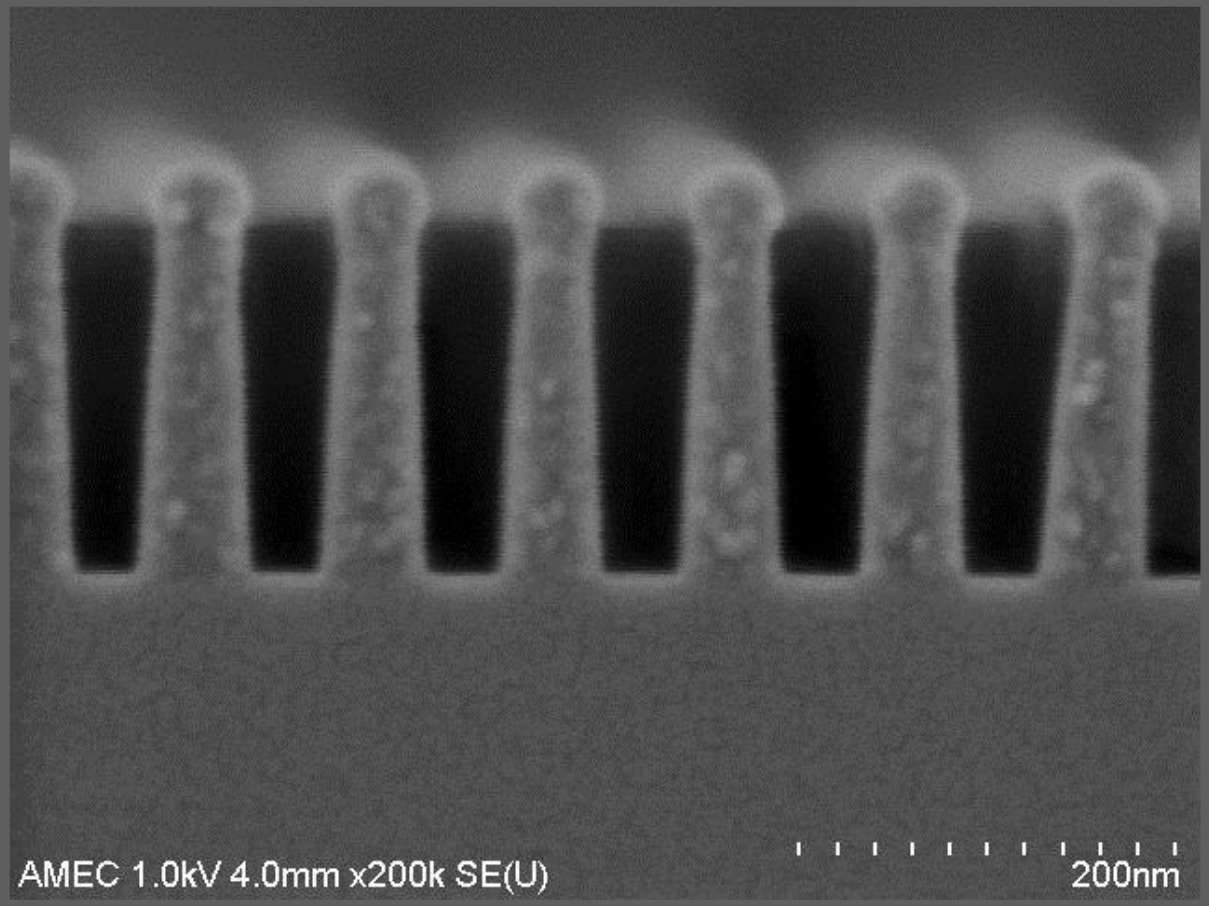
Advanced Lithography Materials for MOE



V. J. Einck, M. Torfeh, A. McClung, D. E. Jung, M. Mansouree, A. Arbabi, J. J. Watkins
ACS Photonics **2021**, *8*, 2400–2409



Organic etch mask materials for glass, semi etch

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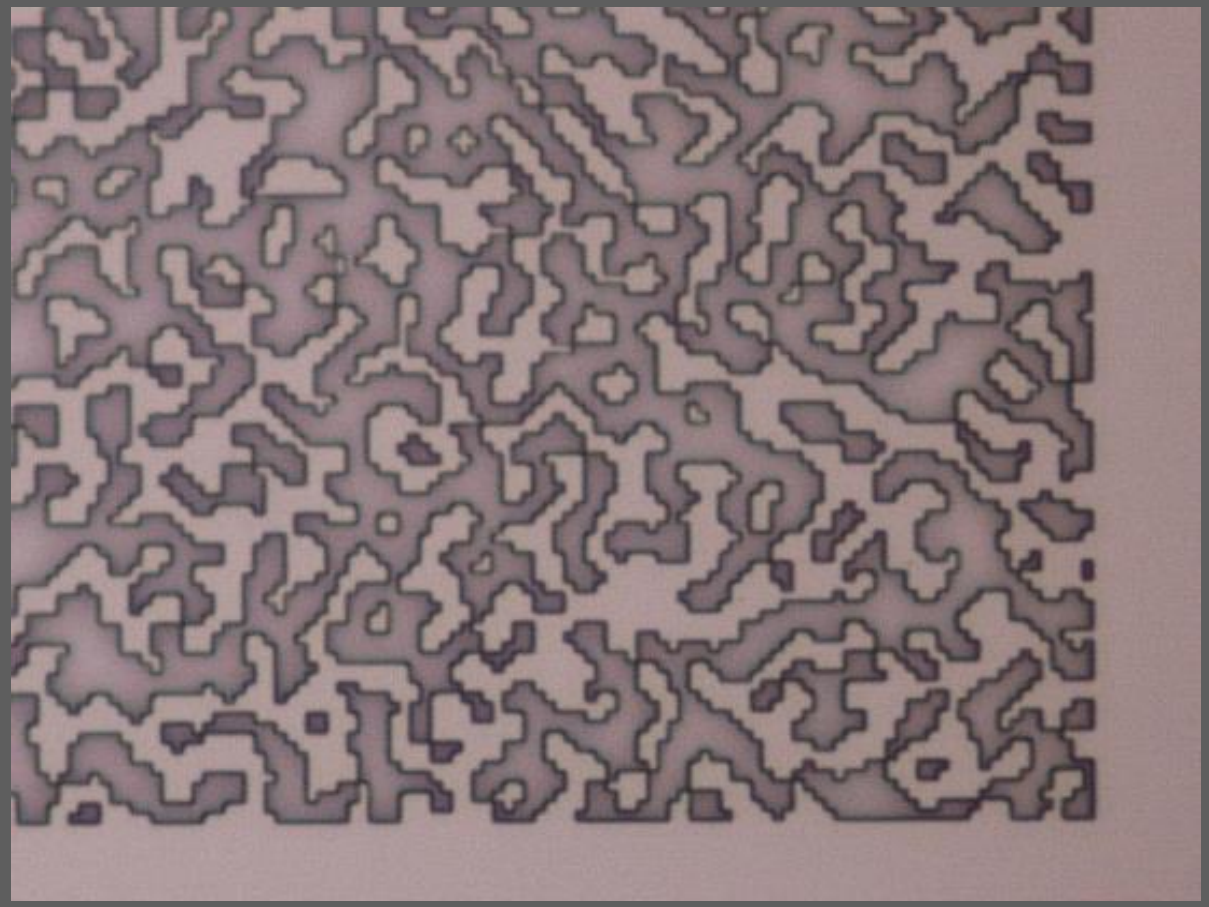
Advanced Lithography Materials for DOE



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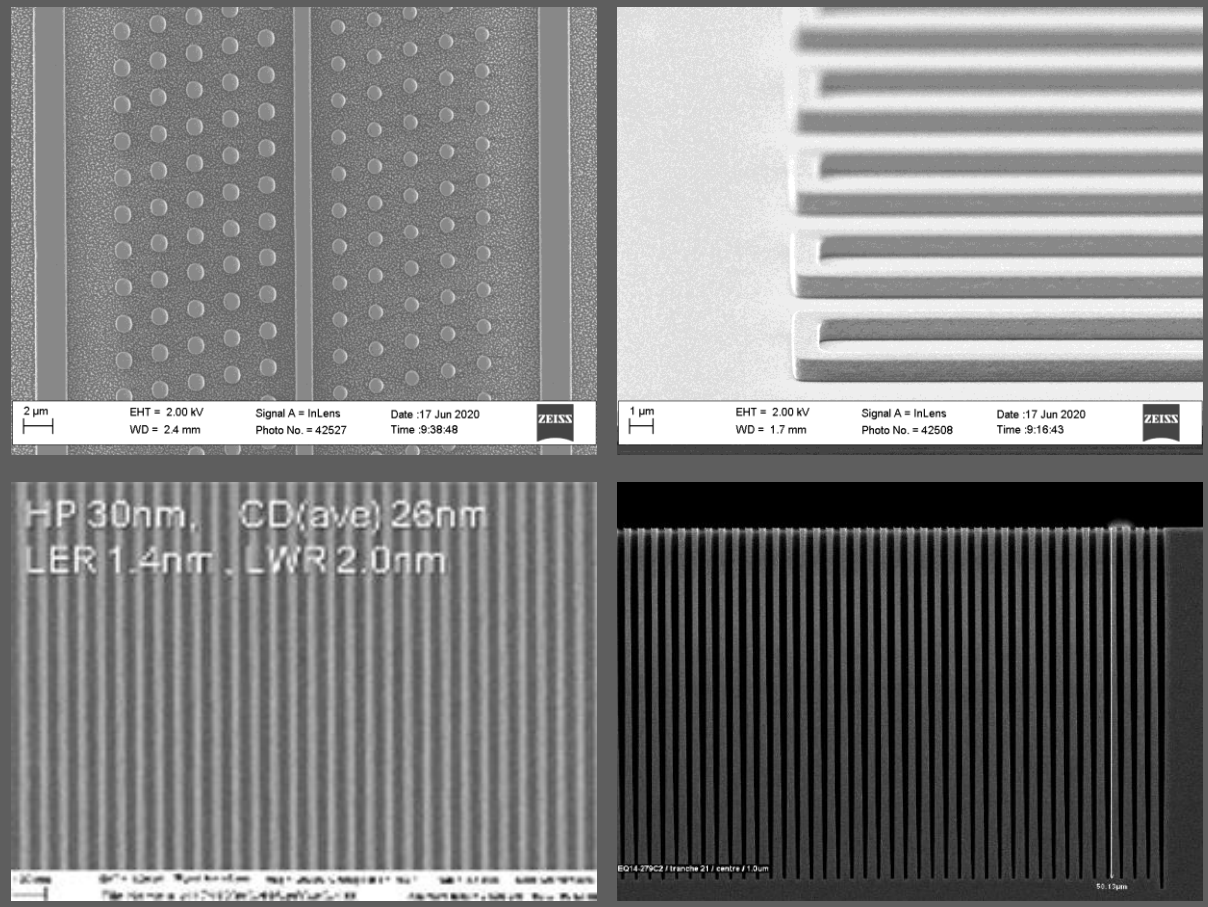

Si-based photoresist, metal oxide etch hard masks

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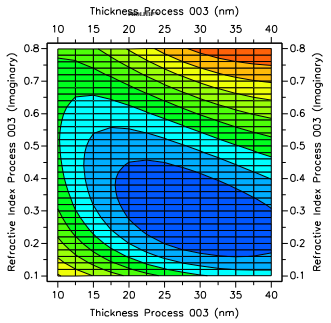
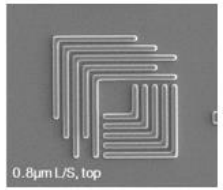
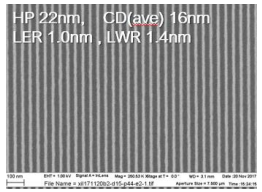
PiBond's Litho Materials

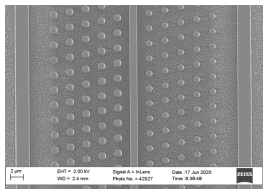
1. Stack and substrate modelling



2 & 3. High Si-% PR
'Bilayer resist'
'Patternable ML'

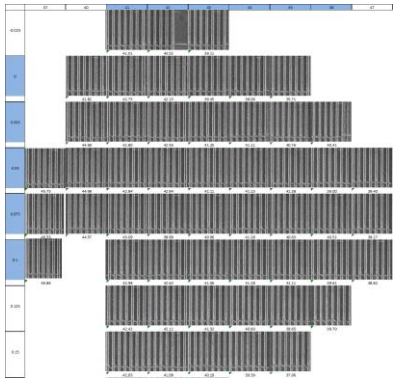


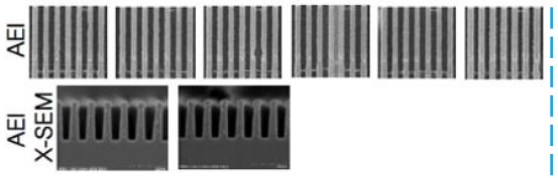


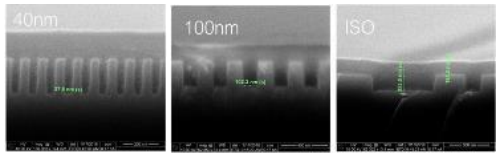


4. Extensive SiBARC, SiHM library

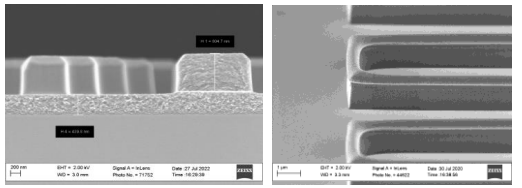
5. Spin-on carbon under layer
Planarizing organic coatings



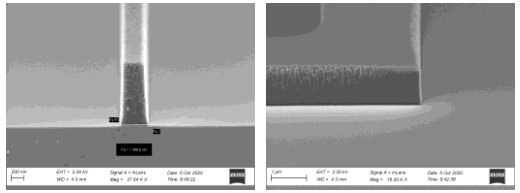


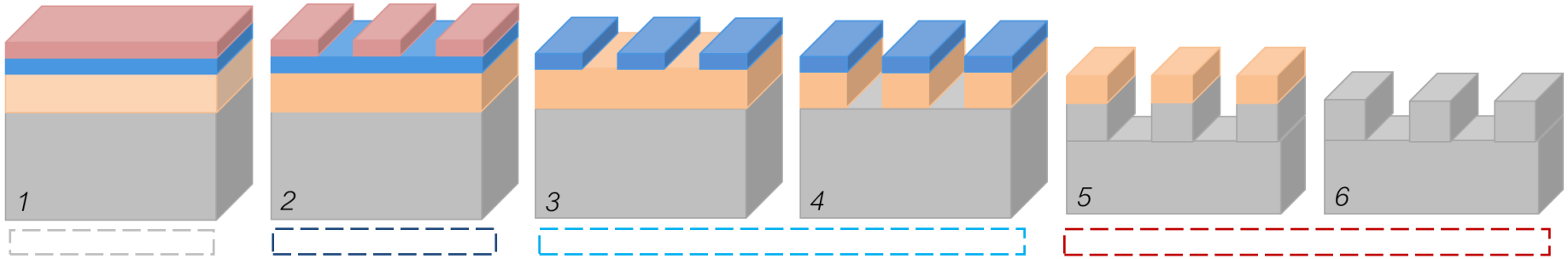


4 & 5. Etch process development



6. Strip solutions and removers





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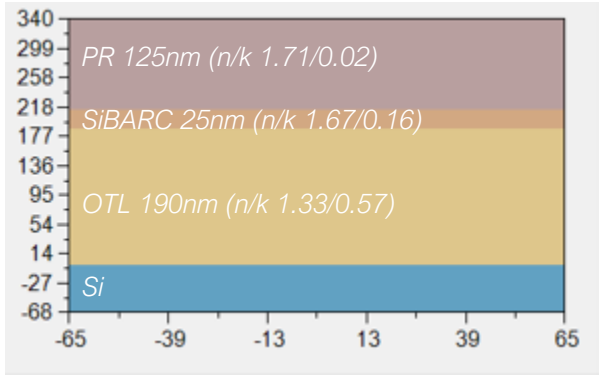
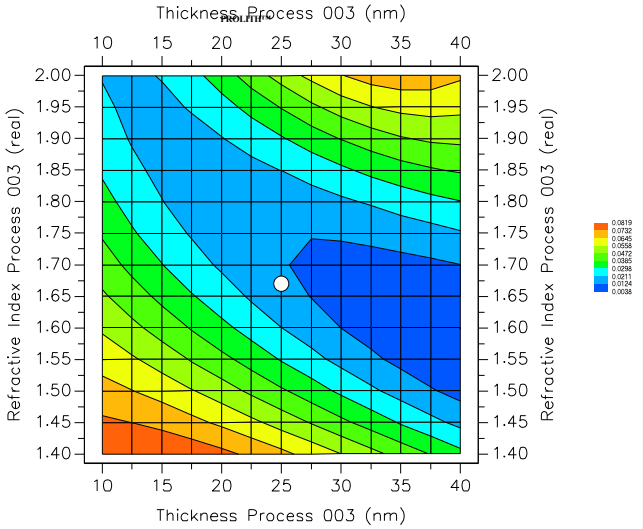
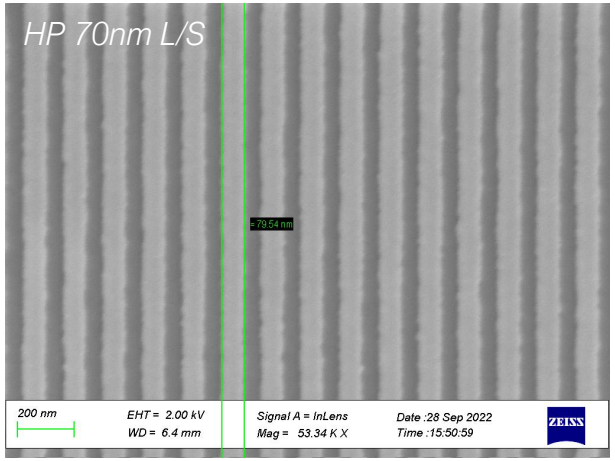
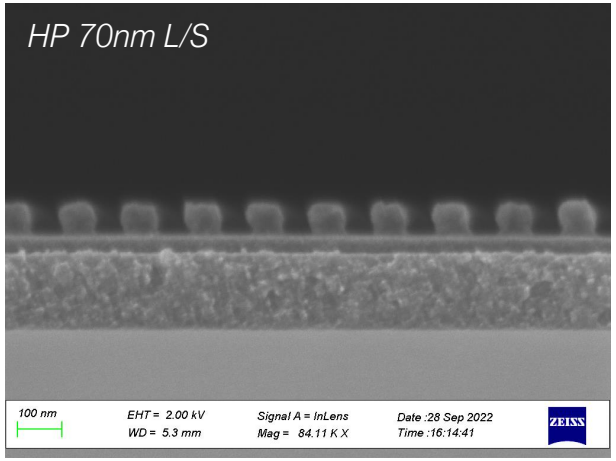
SiBARC & SOC – case study



Stack reflectivity 1.5%







- PiBond SiBARC and OTL thickness and nk adjusted to match photoresist and minimize stack reflectivity
- ArF CAR patterned on PiBond SiBARC / OTL with 70nm L/S
- No peeling or pattern collapse

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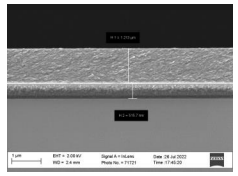
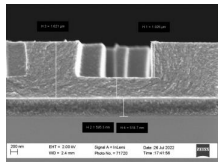
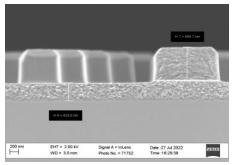
PiBond's Litho Materials

Nanoimprint Turnkey Solution

1. NIL
   Si-based resist

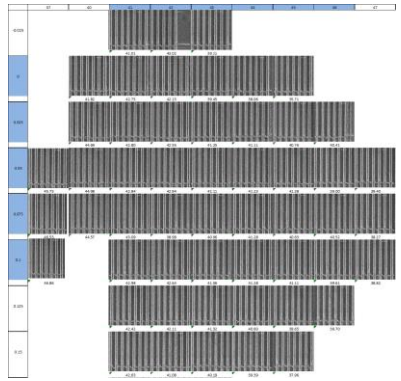


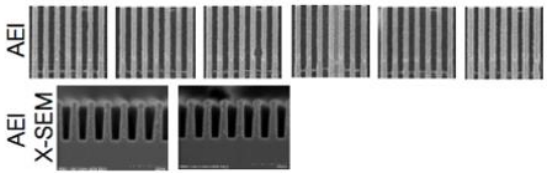


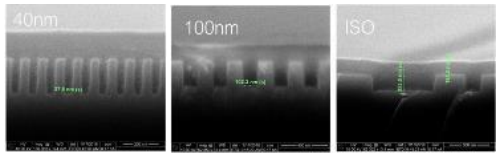


2. Extensive SiBARC, SiHM library

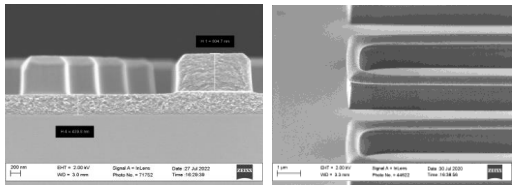
3. Spin-on carbon under layer
   Planarizing organic coatings







4 & 5. Etch process development



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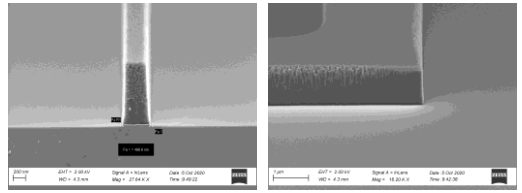

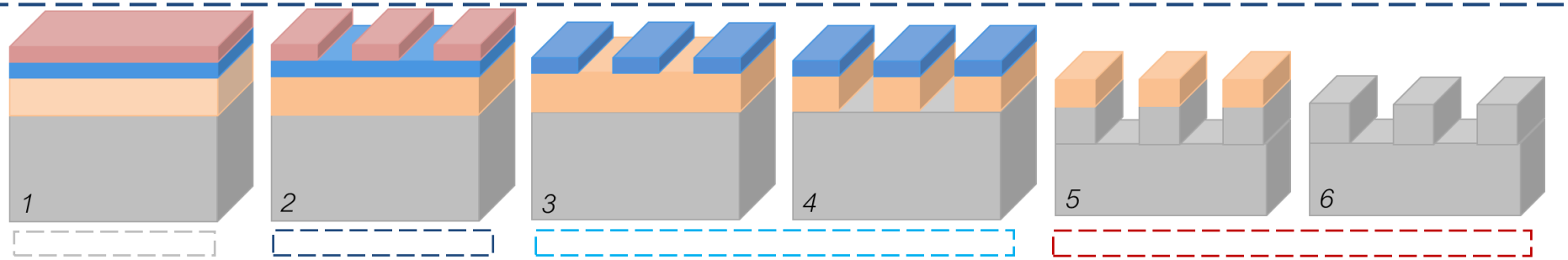

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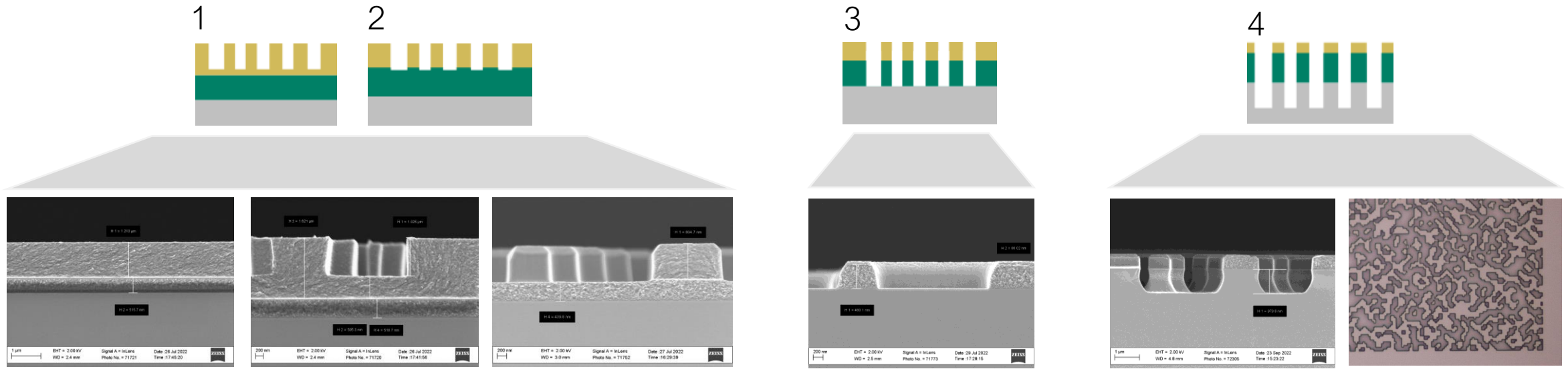
Silicon-based resist – case study

- **Need:** Complex patterns of 100-400nm dimensions. Variable size and pitch
- **Solution:** Use of PiBond's NIL Silicon-based resist and underlayer to transfer pattern to substrate.
- **Benefit:** Avoid costly and challenging optical lithography steps and metal hard masks (e.g. Cr, Ni)

PROCESS FLOW

1. Coat underlayer and NIL Si-PR
2. Pattern NIL Si-PR
3. Pattern transfer to underlayer
4. Transfer to substrate and strip



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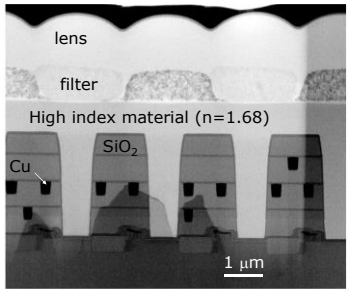
PiBond materials in image sensors

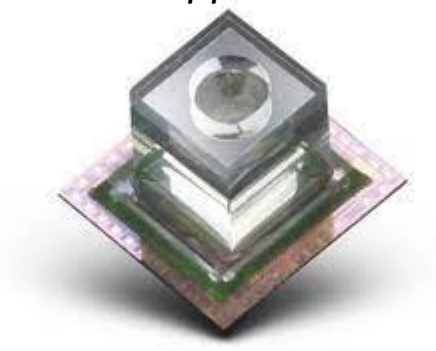
Case example on optical coatings and materials for photonic applications



1. CMOS sensor die

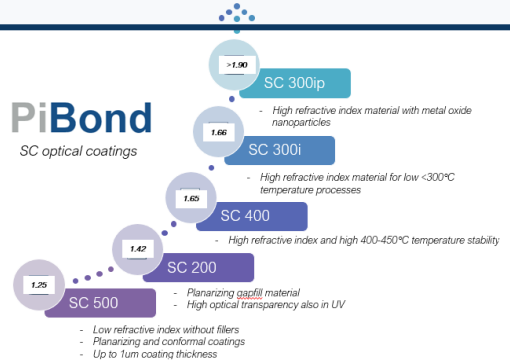
2. Wafer level packaging

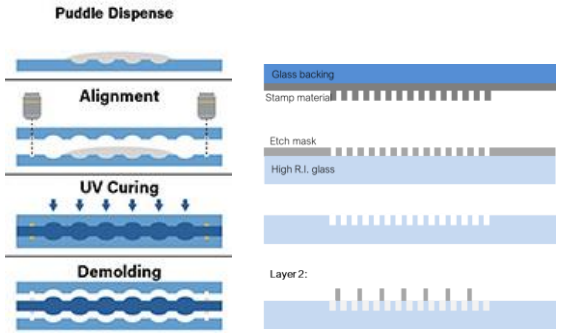
3. Wafer level lenses and stacking

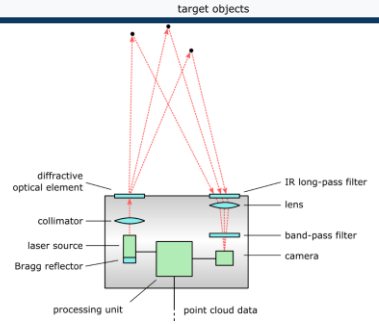


4. Singulation and integration

Optical coatings	Optical adhesives	Materials & processes for flat lenses	Test platform







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Summary

Materials

- Lithography materials
  - Advanced carbon and silicon rich etch mask materials
  - Silicon rich photoresists
  - Materials for both optical lithography and high index substrate patterning
- Optical coatings
  - High and low index coatings and adhesives

Concepts

- Wafer Level Optics including Meta Optical Elements

Thank You!