



'Photomask technology in XR products and system integration'

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SESSION 1:
XR Product and System Integration



TOPPAN
TOPPAN PHOTOMASK



*If YOU can imagine it,
WE can **image** it.*



Outline

- **TPC Introduction**
- **XR device components**
- **What part does Photomask Technology play here ?**

*If YOU can imagine it,
WE can **image** it.*

Toppan Photomask Co., Ltd. (TPC)

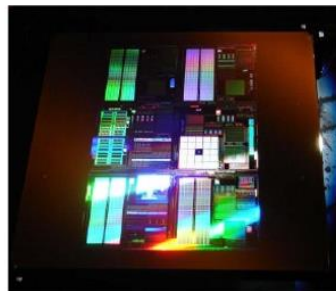
The world's premier provider of photomasks for semiconductors

- **60+ Years** Dedicated to the Industry
- Global Customer Reach
- **8 Manufacturing Facilities** Strategically Located Globally
- Offering the World's **Most Advanced Lithography** Technology
- Including **Nanoimprint Molds** and Other Nano-Fabricated Products



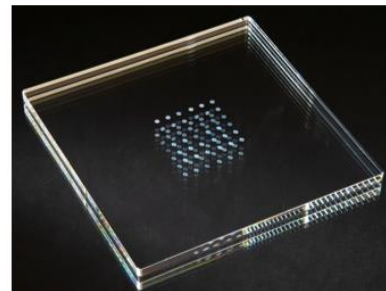
DUV reticle/photomask

Transmissive Mask Lithography



EUV Mask

Reflective Mask Lithography



Nano Imprint Lithography master

Imprint Lithography

TOPPAN PHOTOMASK



1800
EMPLOYEES

7 Countries
8 Factories

● PM Manufacturing Sites

● R&D Centers

● NIL master Mold manufacturing

NIL Master molds from Dresden (Qz) and Japan (Si wafer)

XR Device is a system

composed of multiple modules to provide the individual functionalities

Image computing & connectivity (IC 'chips', WLO...):

- **Projection** lithography : Photomasks

Sensing (sensors, metalenses, WLO):

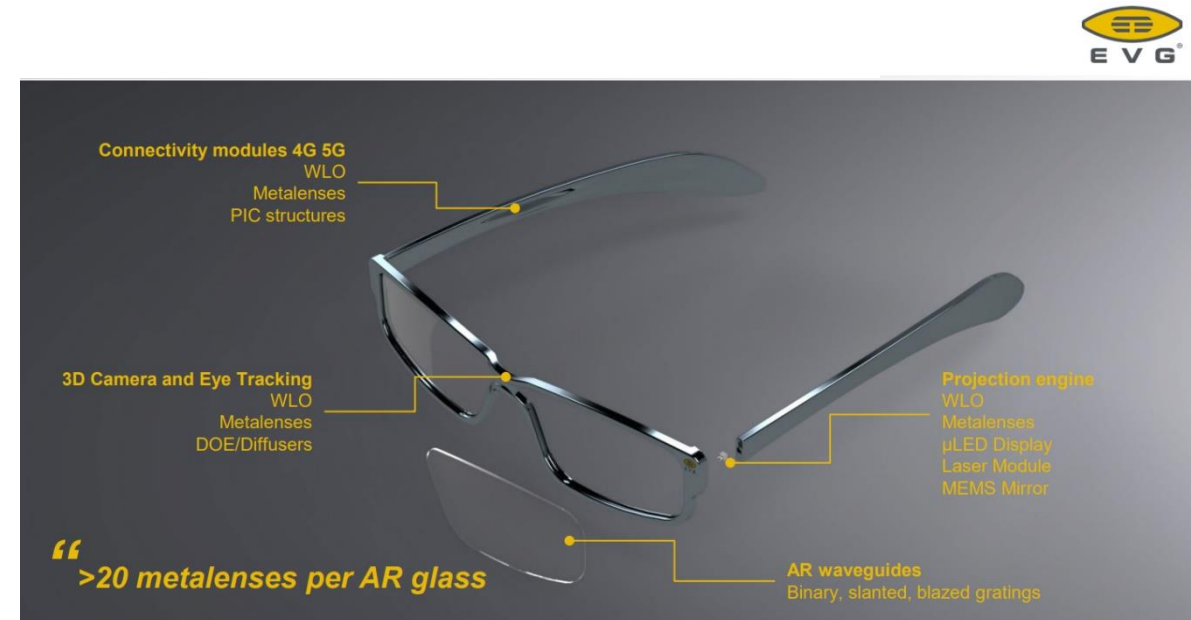
- Projection lithography : Photomasks
- **NanoImprint** Lithography: Masters molds

Light steering (waveguides):

- Projection lithography → Photomasks
- NanoImprint Lithography → Masters molds
- **Proximity** lithography → Photomasks

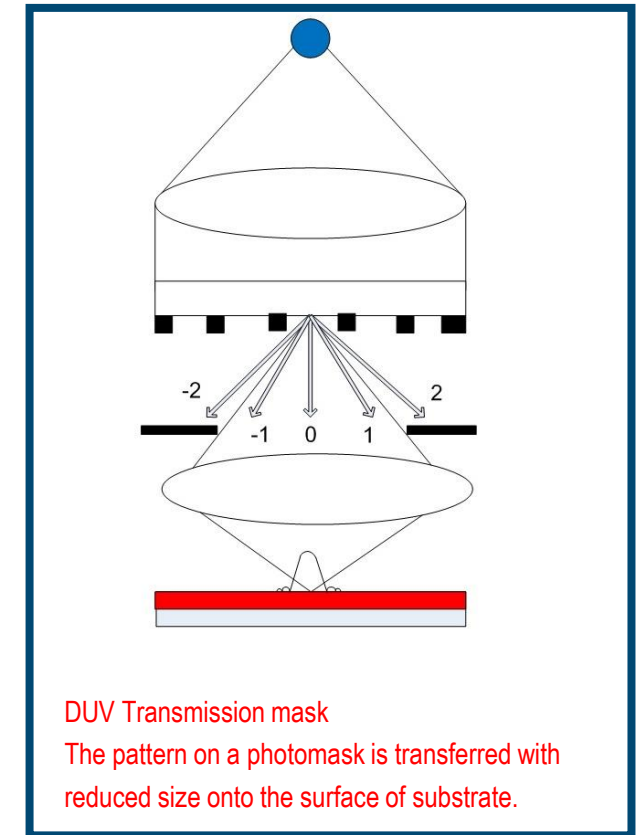
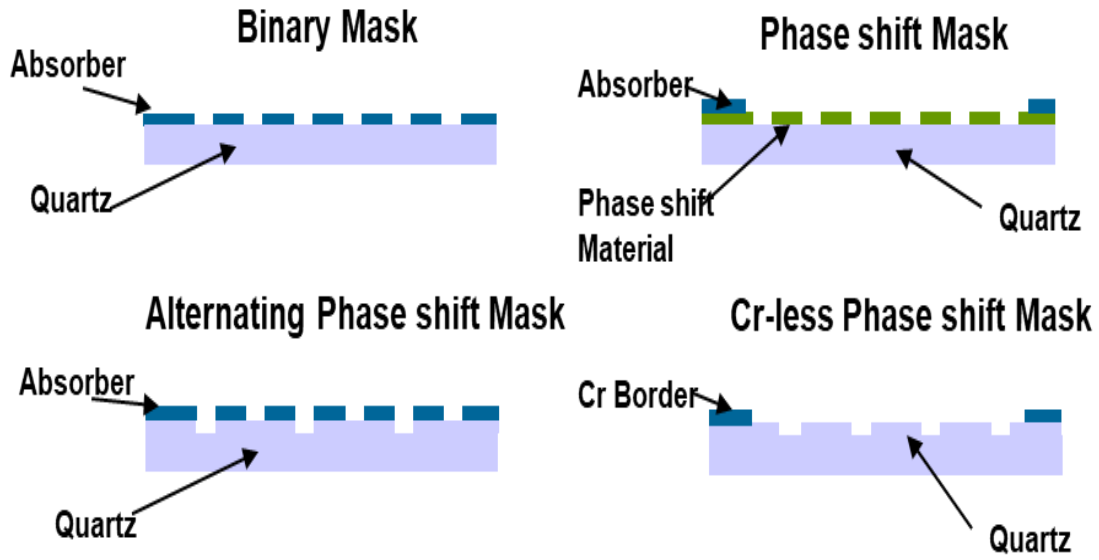
→ each module is manufactured using a 'Replication' Template

→ High quality templates for all lithography techniques are manufactured using **Photomask Technology** at industrial quality grades that enable the best performance

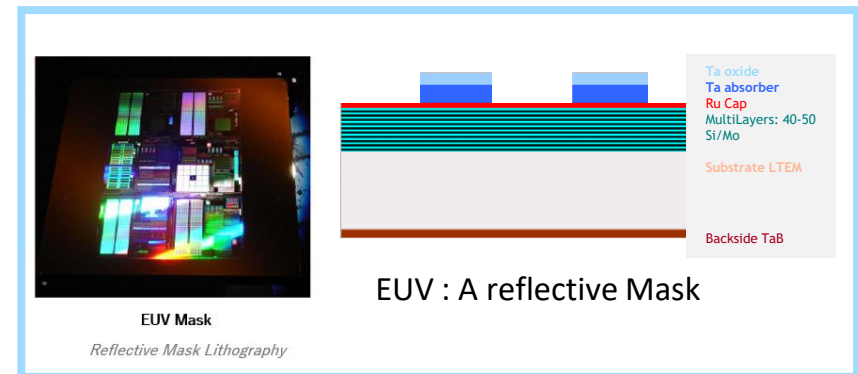


Projection Lithography

Generates the image by diffracted light created by a photomask

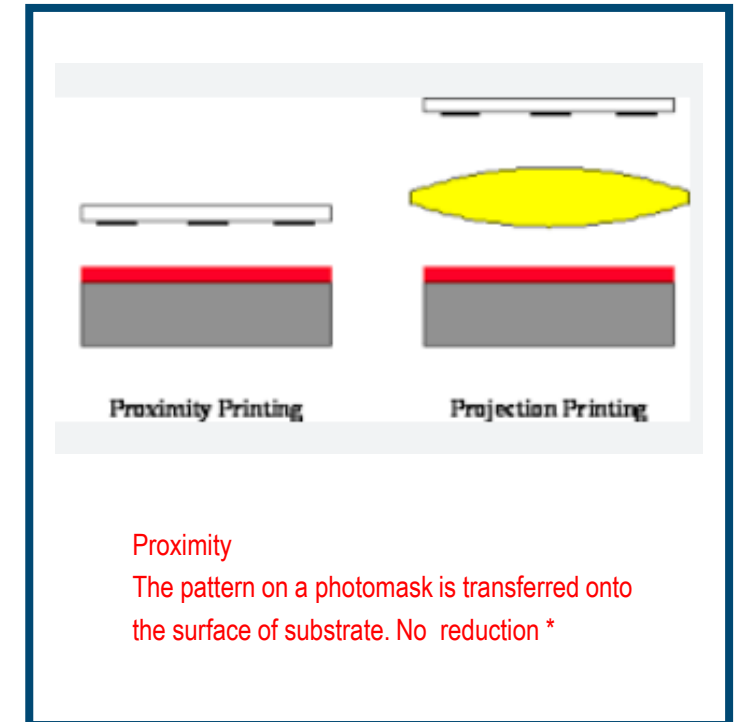
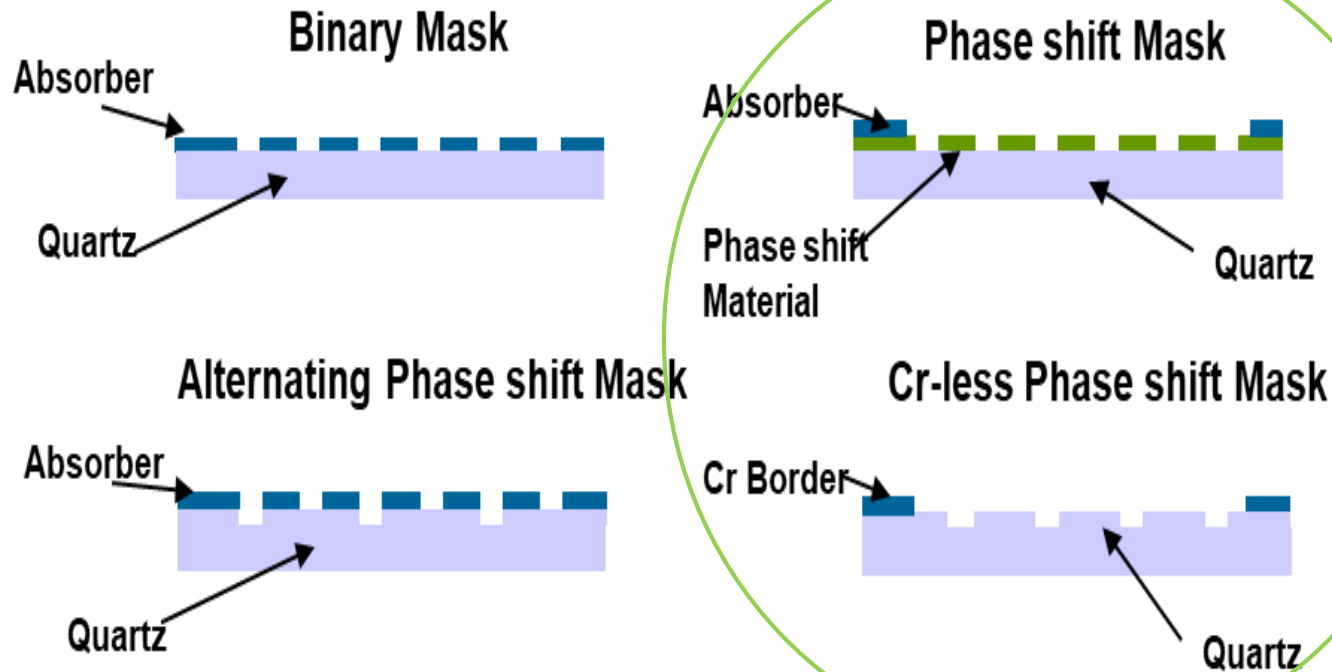


- Many mask types with different absorbers are used for different applications
- EUV masks
- And many other mask types available
 - e.g. Greyscale etc.



Proximity Lithography

Generates the image by near-field of light created by a photomask

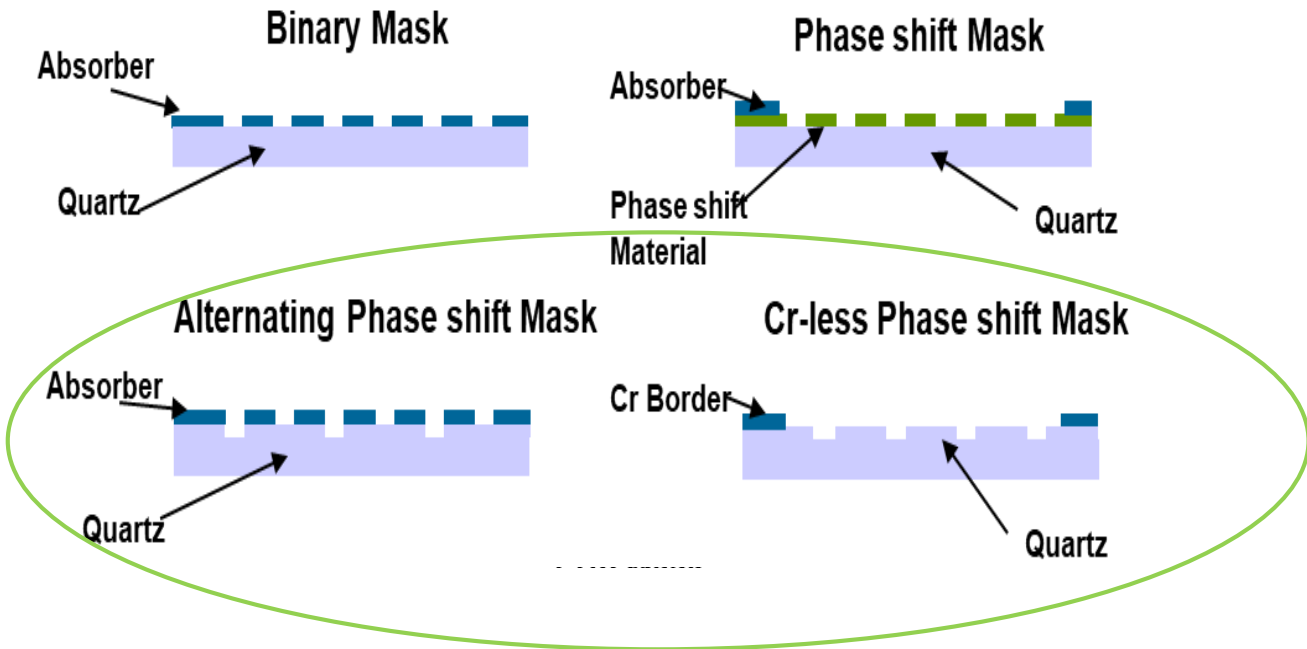


- Special application of phase shift photomasks
 - including DTL (Displacement Talbot Lithography)*
- Phase shift can be achieved by a dedicated attenuating material or by quartz etched pattern

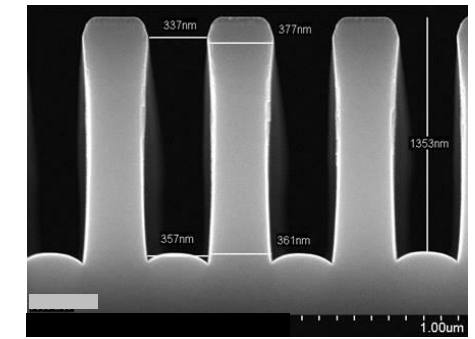
NIL Master & Optical Devices

NIL master: The pattern is etched into substrate and used as stamp

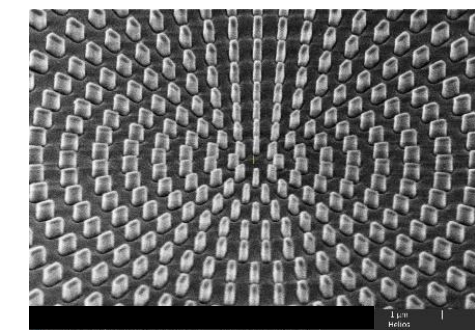
Optical devices: Patterned Quartz substrate is deployed as optical element



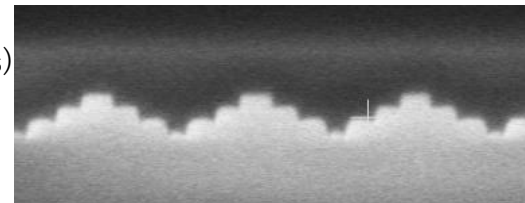
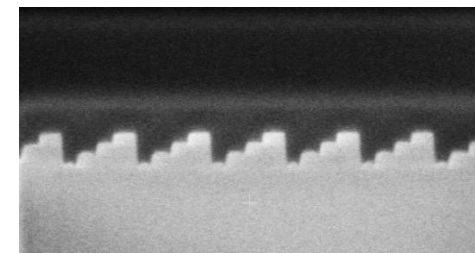
Deep-etch Quartz gratings
(e.g. laser applications)



MetaLenses mold
(e.g. flat optics)

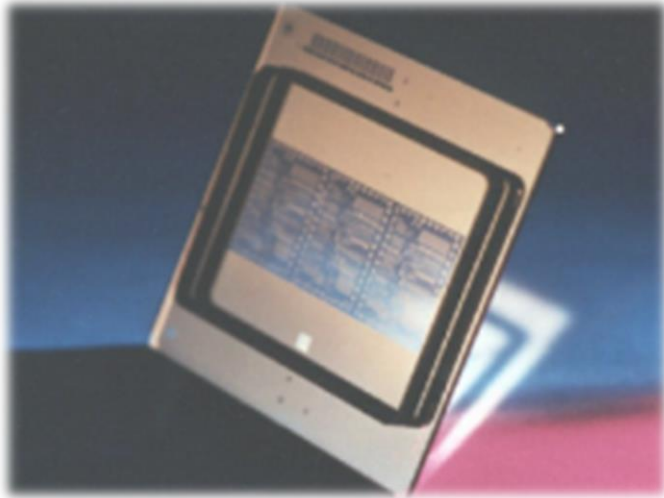


Multi-level gratings
(e.g. NIL master for AR glasses)



- Quartz etch products benefit from established mask making processes using same tool sets as for advanced photomask types.
- Volume shipments annually

PhotoMasks to NIL Mastering



Transmissive Mask Lithography



Reflective Mask Lithography

PhotoMask making:

- ✓ Patterning using **EBL**
- ✓ Etching perpendicular into the substrate/absorber
- ✓ High resolution and precision
- ✓ Highly controlled processes
- ✓ High level of cleanliness
- ✓ Industrialized process
- ✓ Established standards

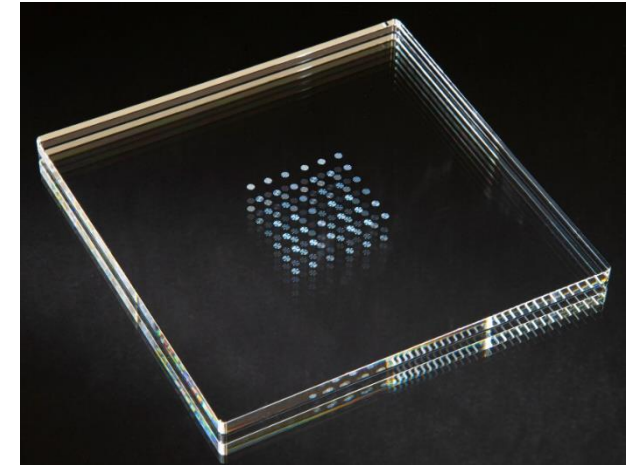
Photomask to NIL mastering

Photomask technology is well-suited to AR specifics by **adding**:

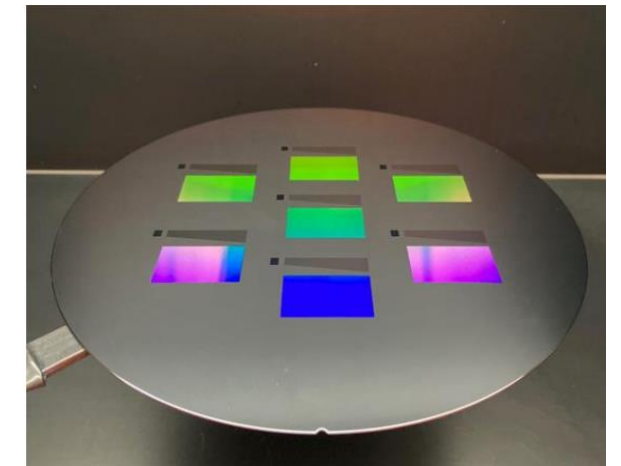
- ✓ Any angle features
- ✓ Arbitrary shaped patterns – **MBMW** litho
- ✓ Slanted/Blazed/Staircase etch profiles
- ✓ Variable Etch Depth slope in substrate

Nano Imprint Lithography

Metalens Application

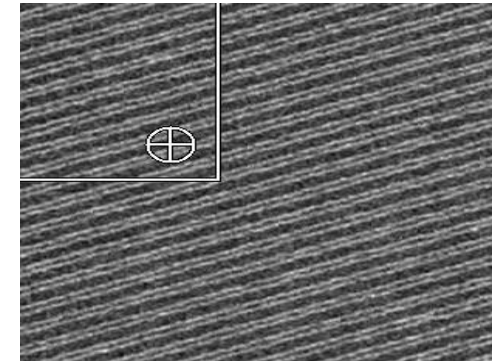
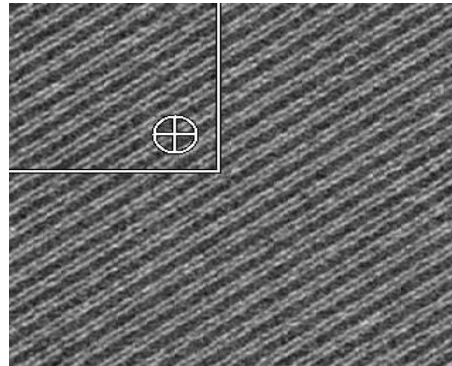
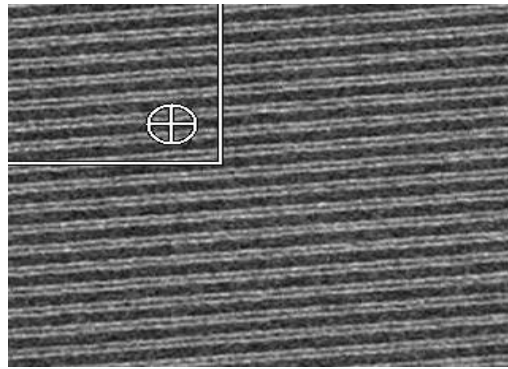


AR/VR/MR Application

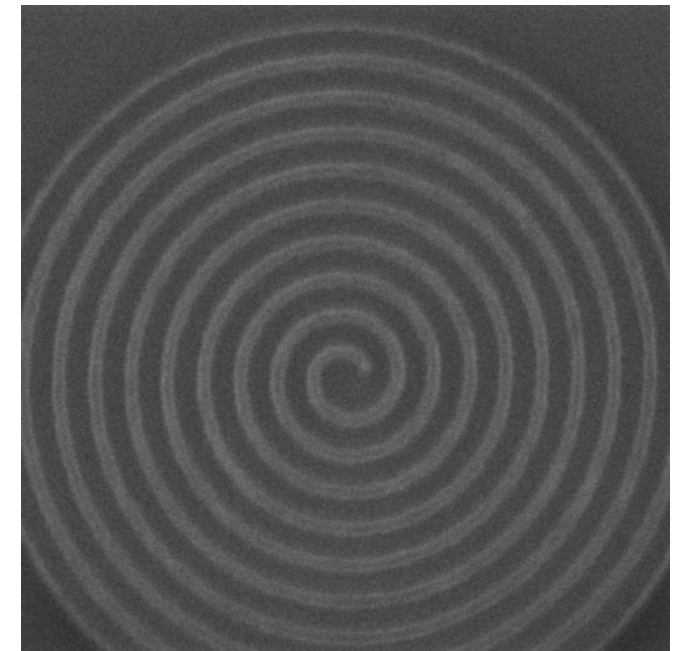
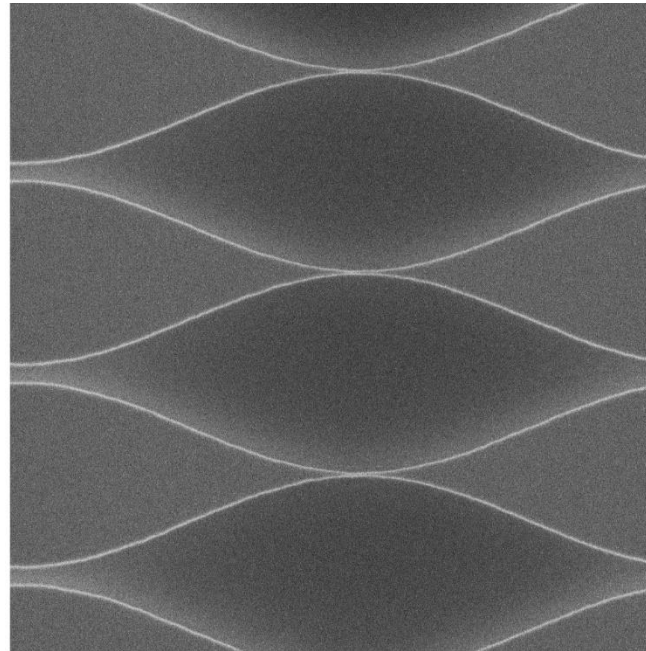
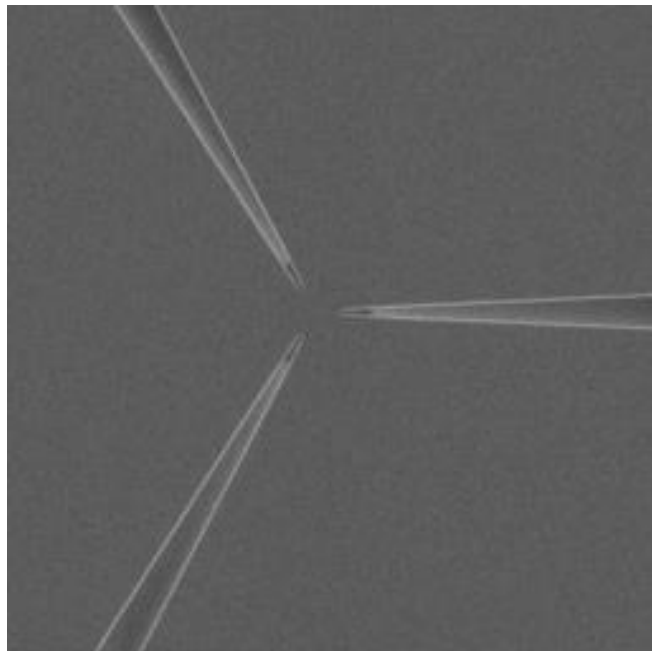


Patterning.....

Any angled features and arbitrary shapes



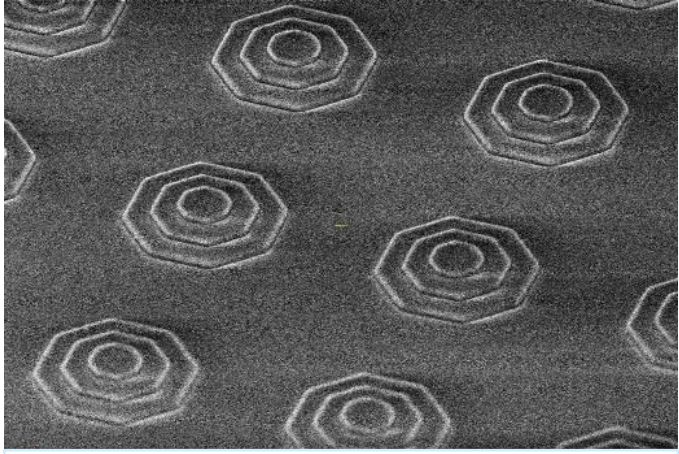
Angles features using Single beam **EBL**



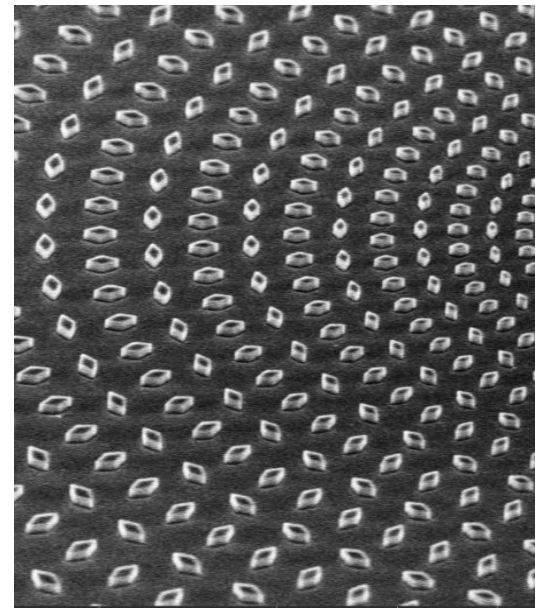
Arbitrary shaped patterns – **MBMW** litho

EBL – EBeam Lithography
MBMW-MultiBeamMaskWriter

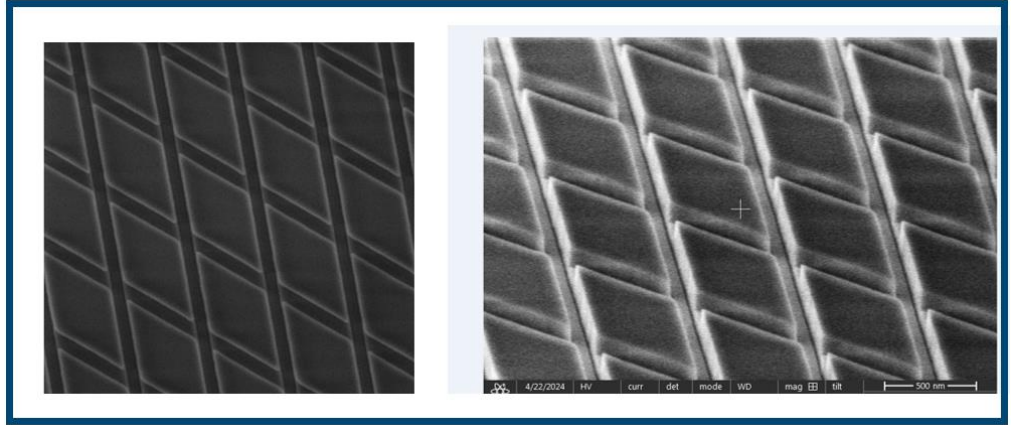
Patterning 3D patterns



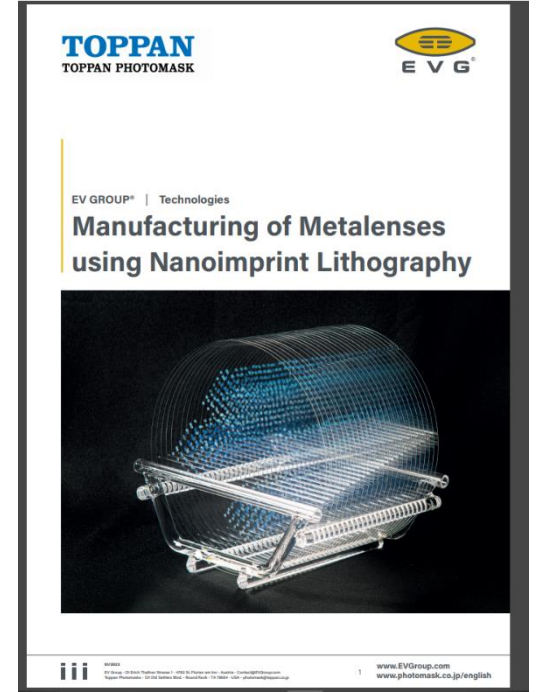
Octagon pyramids



Meta-atoms of 65nm sized etched into Quartz



Overlapping Grids with different depths

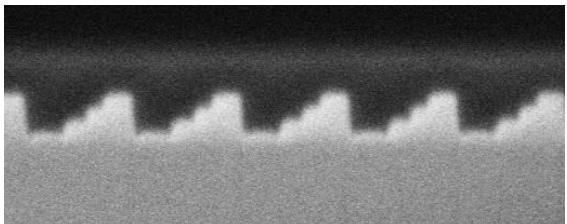
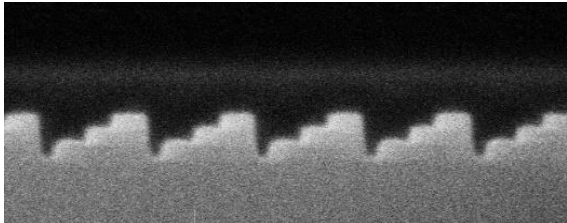


Gratings with 2D/3D etching

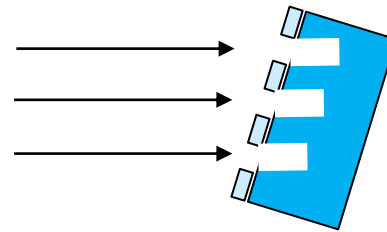
Multisteps Staircase



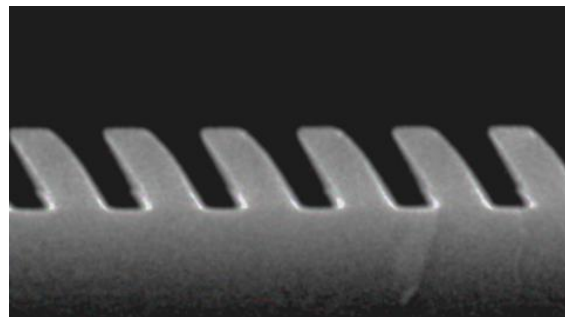
- **Multi-level EBL exposure for optimum overlay**
- Binary etching



Slanted



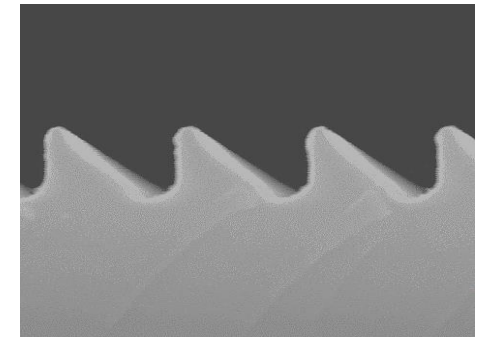
- **Etching** with the mask tilted at given **orientation and angle**



Blazed



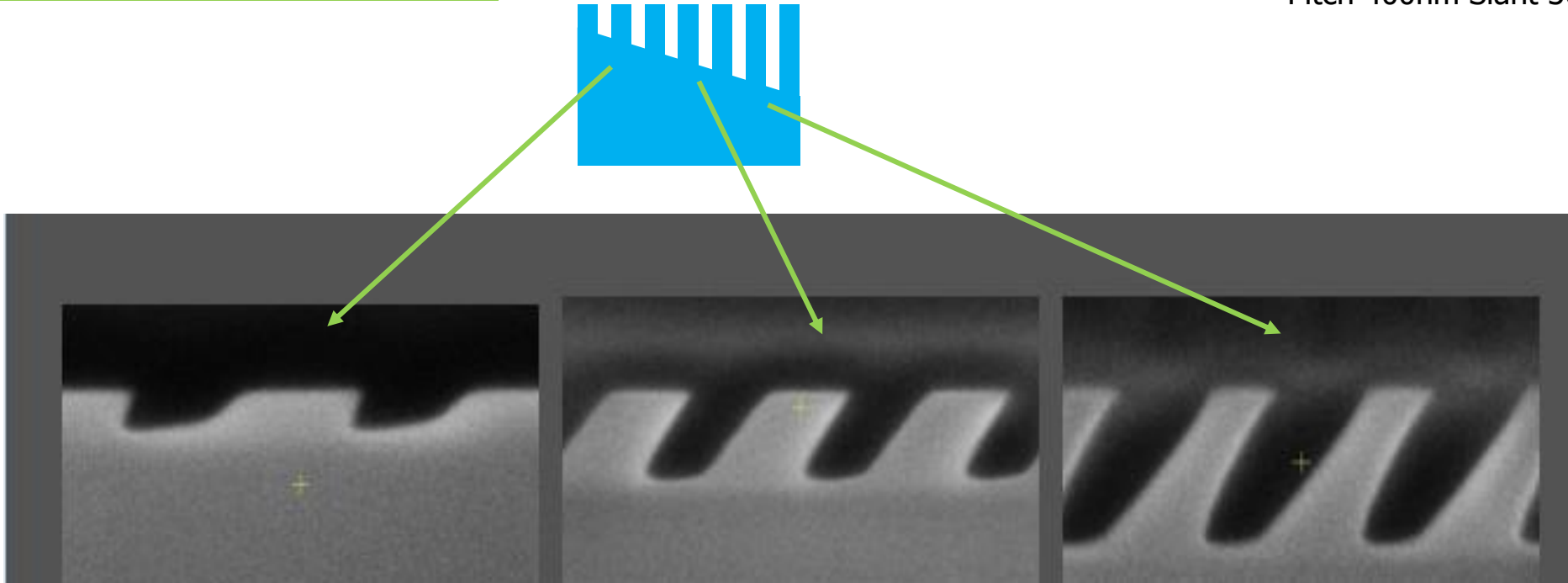
- Etching : **Specific etch** strategy to realise the **Blazed** shape



Gratings: Variable Etch Depth

Variable Etch Depth Slanted

Depth profile 50nm to 350nm
Pitch 400nm Slant 30°



- Slanted, or binary, etch realized with **continuously varying etch depth**
- **Non-linear** depth profiles also possible

Summary

- Photomask technology is the foundation of any 'replicate' Template for design transfer using lithographic processes onto substrates, to generate the various modules in XR systems.
- The XR industry can benefit from the well established industrialized processes and controls in place to serve other industries.

*If YOU can imagine it,
WE can **image** it.*

Request to this group:

Possible to deliver all replicate template types for the modules on XR system,

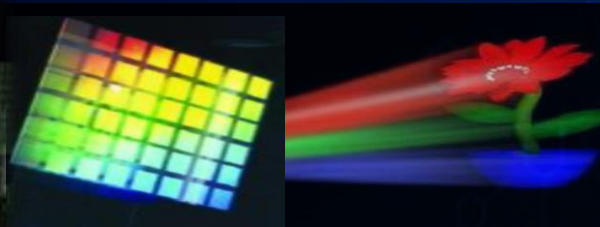
→ just advise on the requirements and your ideas for the future !

Photomask technology is an enabler for XR systems

If YOU can imagine it,
WE can **image** it



Thank You for your Attention!



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