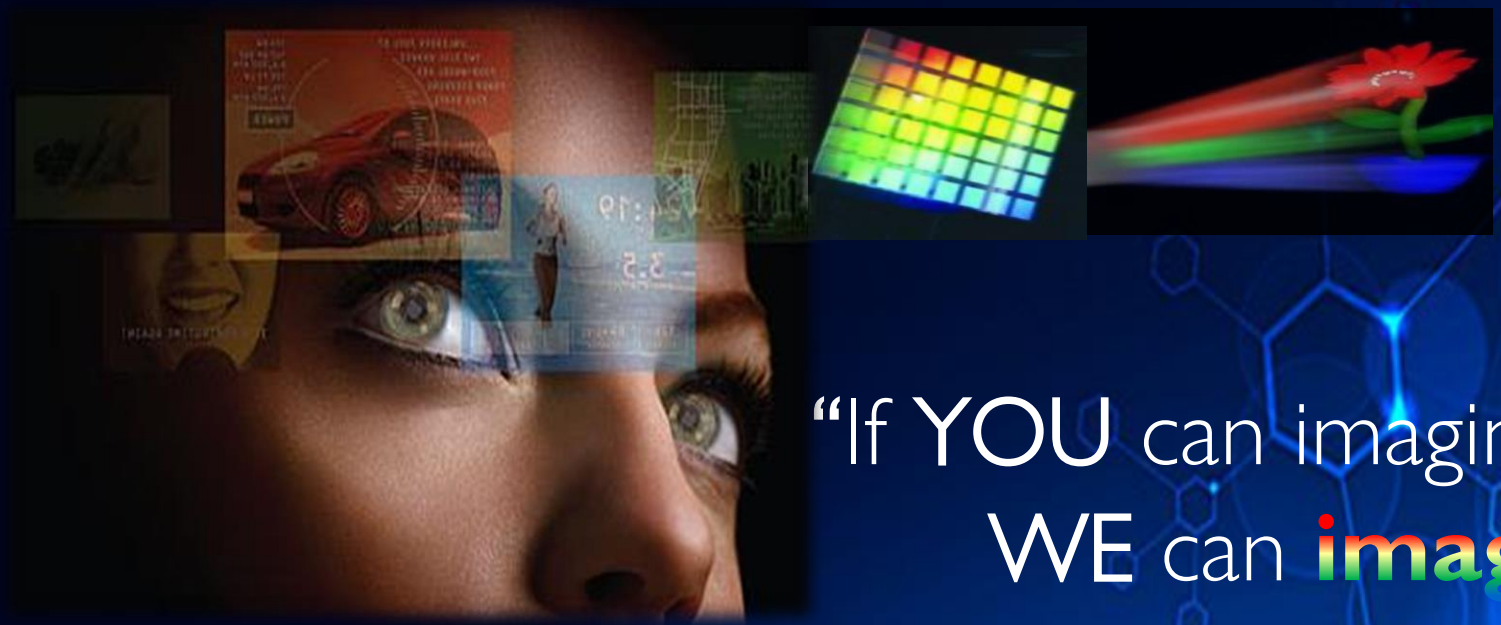
TOPPAN

TOPPAN PHOTOMASK



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

AR Glass

Sensing Device

Bio Chip

Holography

MEMBER OF EPIC

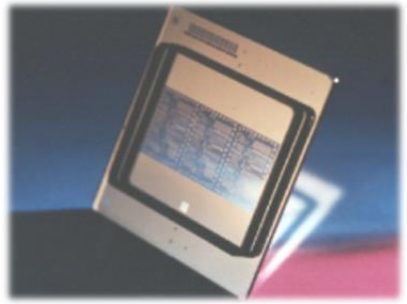
EUROPEAN PHOTONICS INDUSTRY CONSORTIUM

Bríd Connolly ,
Andreas Frangen

# Toppan Photomask Co., Ltd. (TPC)

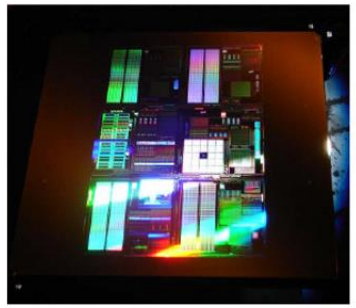
The world's premier provider of photomasks for semiconductors

- Company Name — Toppan Photomask Co., Ltd.
- Location — HQ Tokyo
- Business start — April 1st, 2022
- President — Teruo Ninomiya
- Shareholders — Toppan Inc. 50.1%<br>Integral Corporation 49.9%
- Headcount — 1,800 (as of April 1st, 2022)
- Locations — 8 manufacturing facilities in key geographical locations

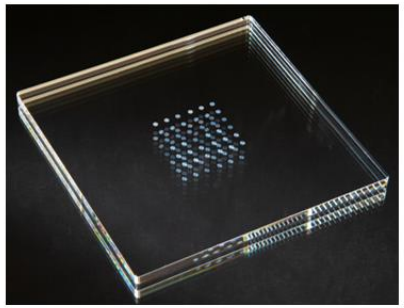
DUV reticle/photomask

*Transmissive Mask Lithography*



EUV Mask

*Reflective Mask Lithography*



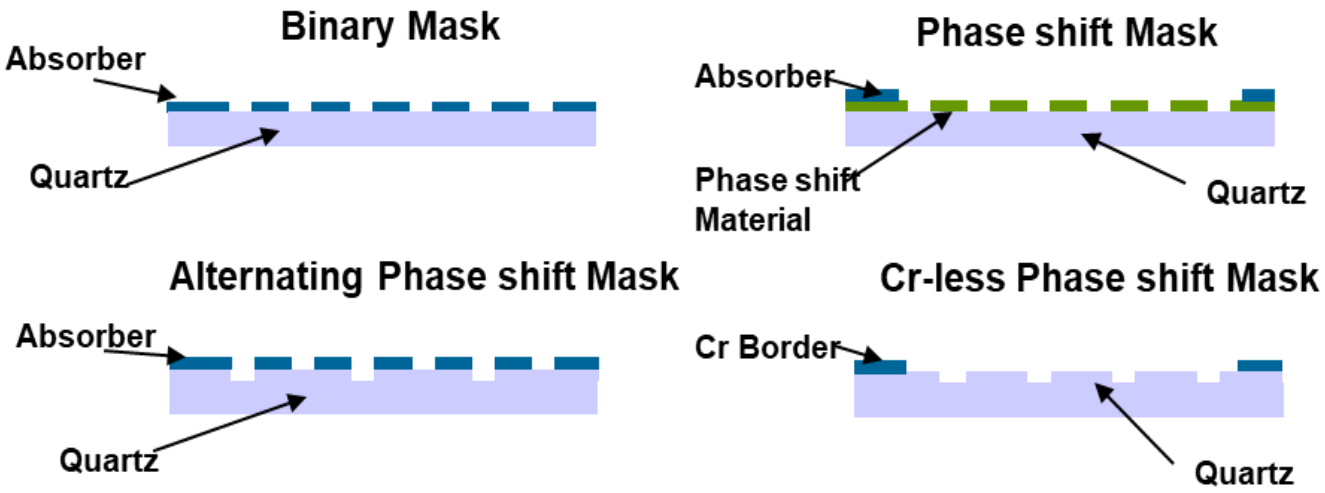
Nano Imprint Lithography master

*Imprint Lithography*

# Photomasks and NIL Masters

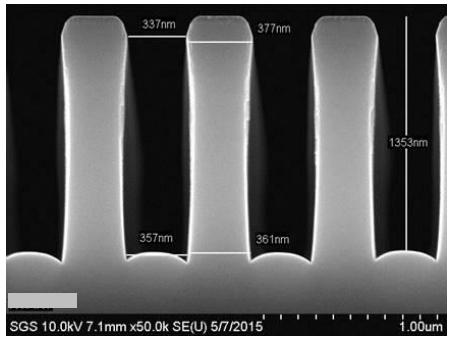
- Quartz-etched patterns are also used for projection lithography photomasks

→ Same technology used to manufacture NIL masters

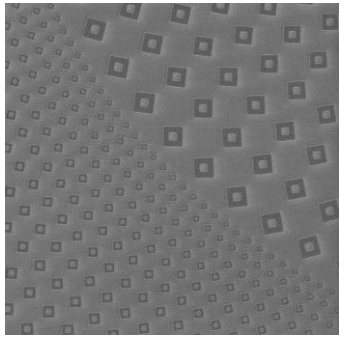



**quartz etched products are running HVM**

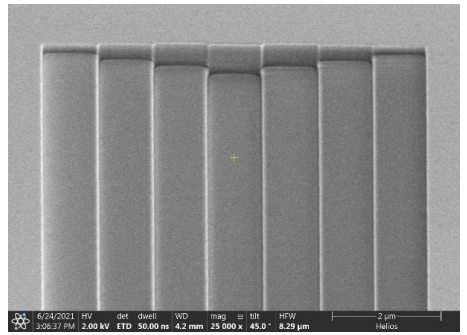
Deep-etch Quartz gratings
(e.g. laser applications)




MetaLenses
(e.g. flat optics)

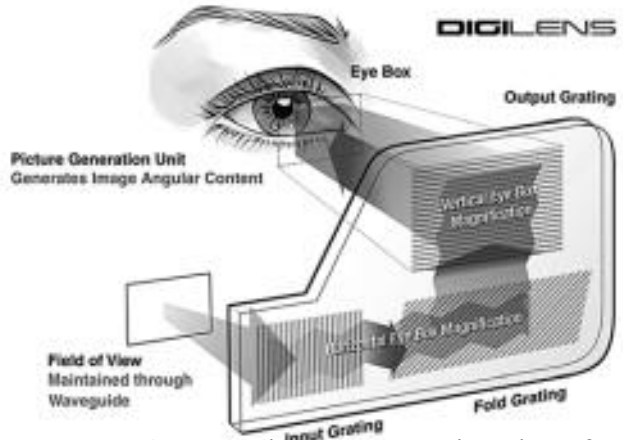


Multi-level gratings
(e.g. NIL master for AR glasses)



# NIL Master Requirements

## AR/VR Devices

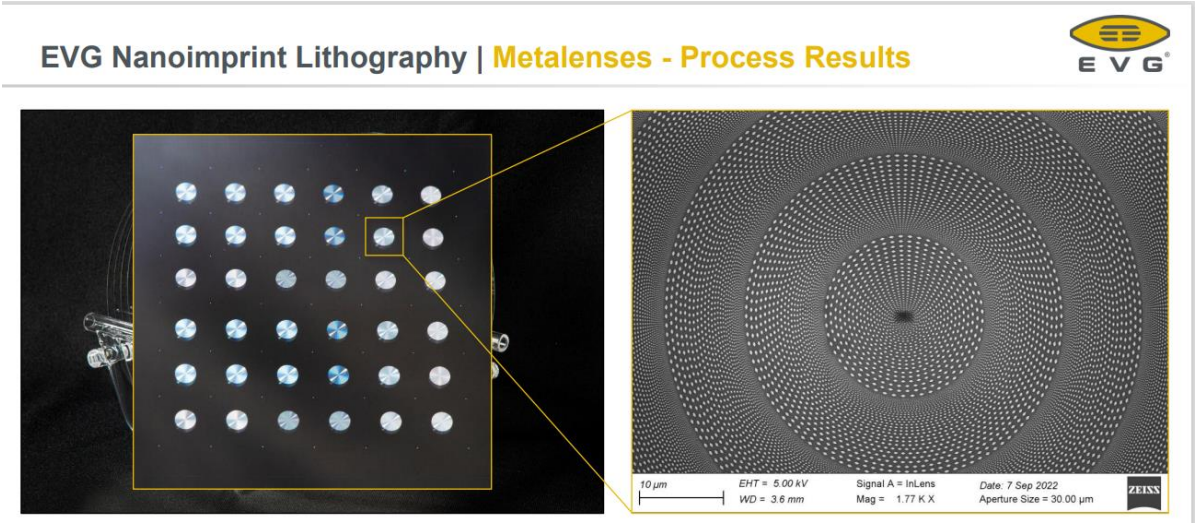



B.C. Kress, I. Chatterjee „Waveguide combiners for mixed reality headsets" de Gruyter, Nanophotonics 10/2021

Consist of gratings that require:

- L/S gratings of arbitrary orientations
- Precise accuracy of orientation angle
- Minimal periodic placement errors
- Non-vertical Grating profiles
- Various etch depths within one grating

## Metalens-based Optics

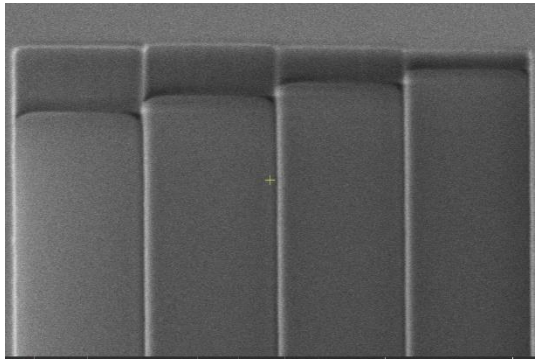


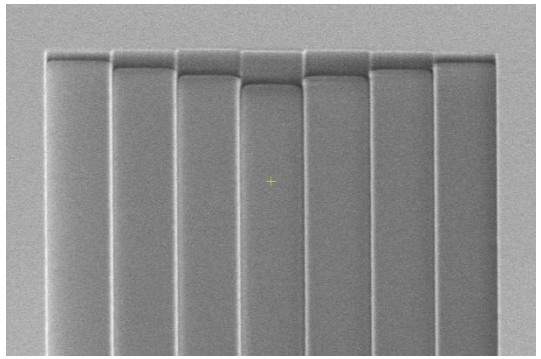

- High resolution
- Meta-atoms of arbitrary shapes and orientations

→Our applied Photomask technology is the enabler of these new segments!

# Staircase Gratings & 3D Pattern

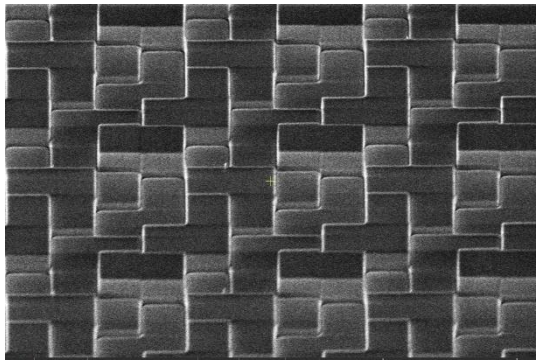
- Staircase is an option for non vertical profiles
  - discrete steps of various widths and depths

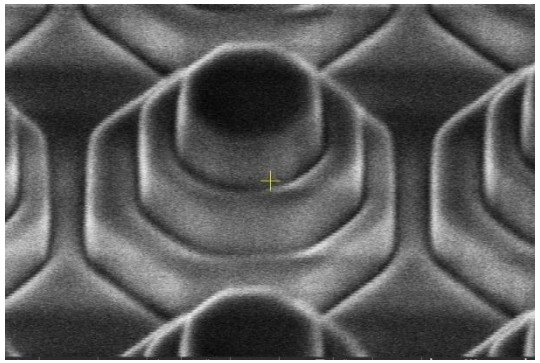




Preliminary samples

- 3D pattern for other optical applications

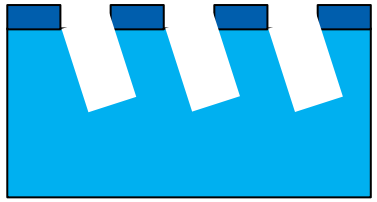


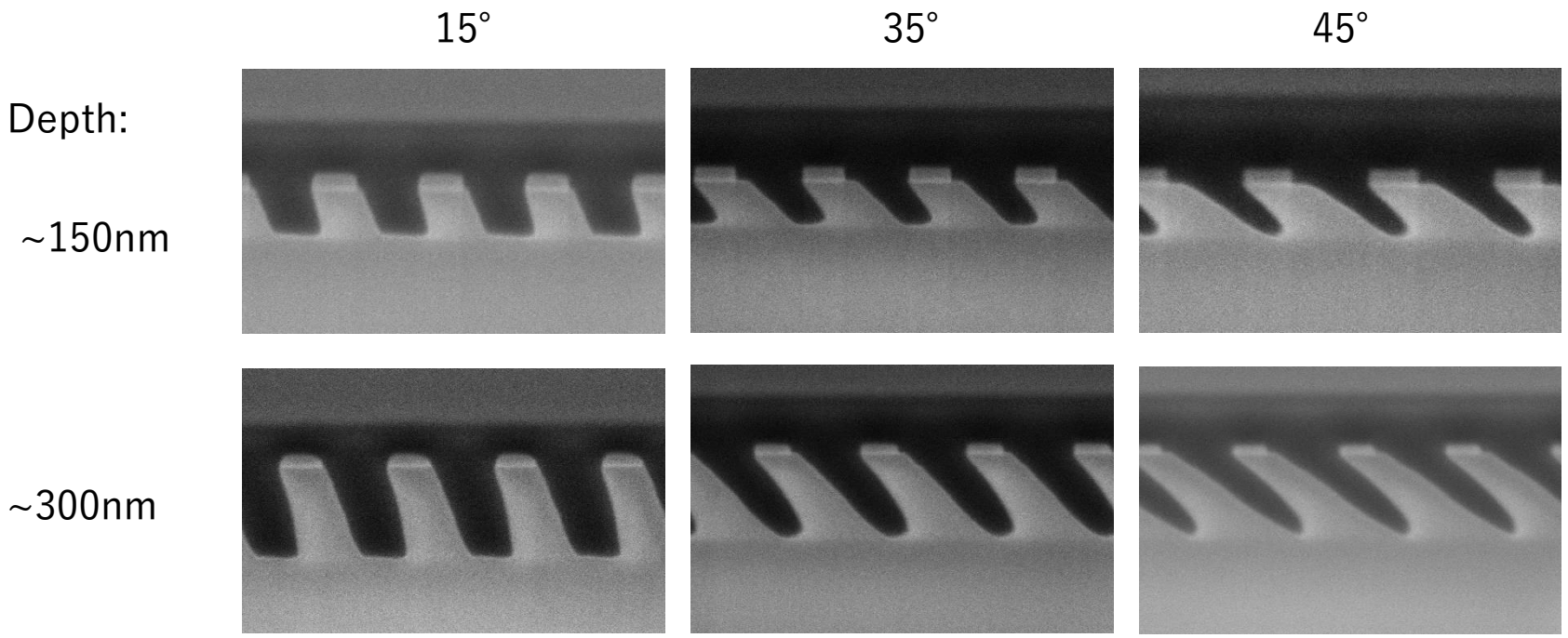


Preliminary samples

# Slanted Gratings

- AR/VR Gratings typically require non-vertical profiles



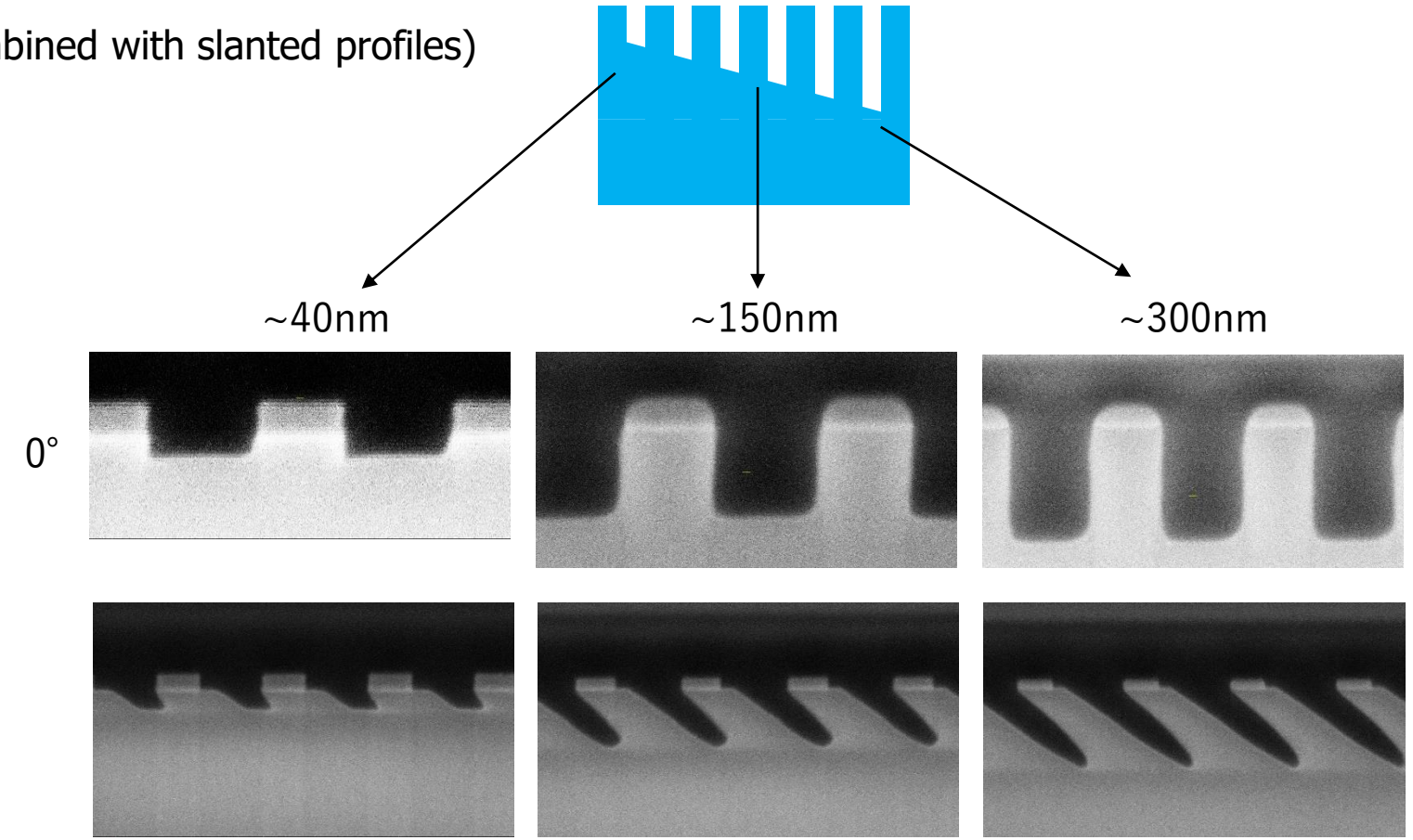



150nm 1:1 Lines/Space
(HM still on top)

# Varying Etch Depth

- Gratings can require various etch depths

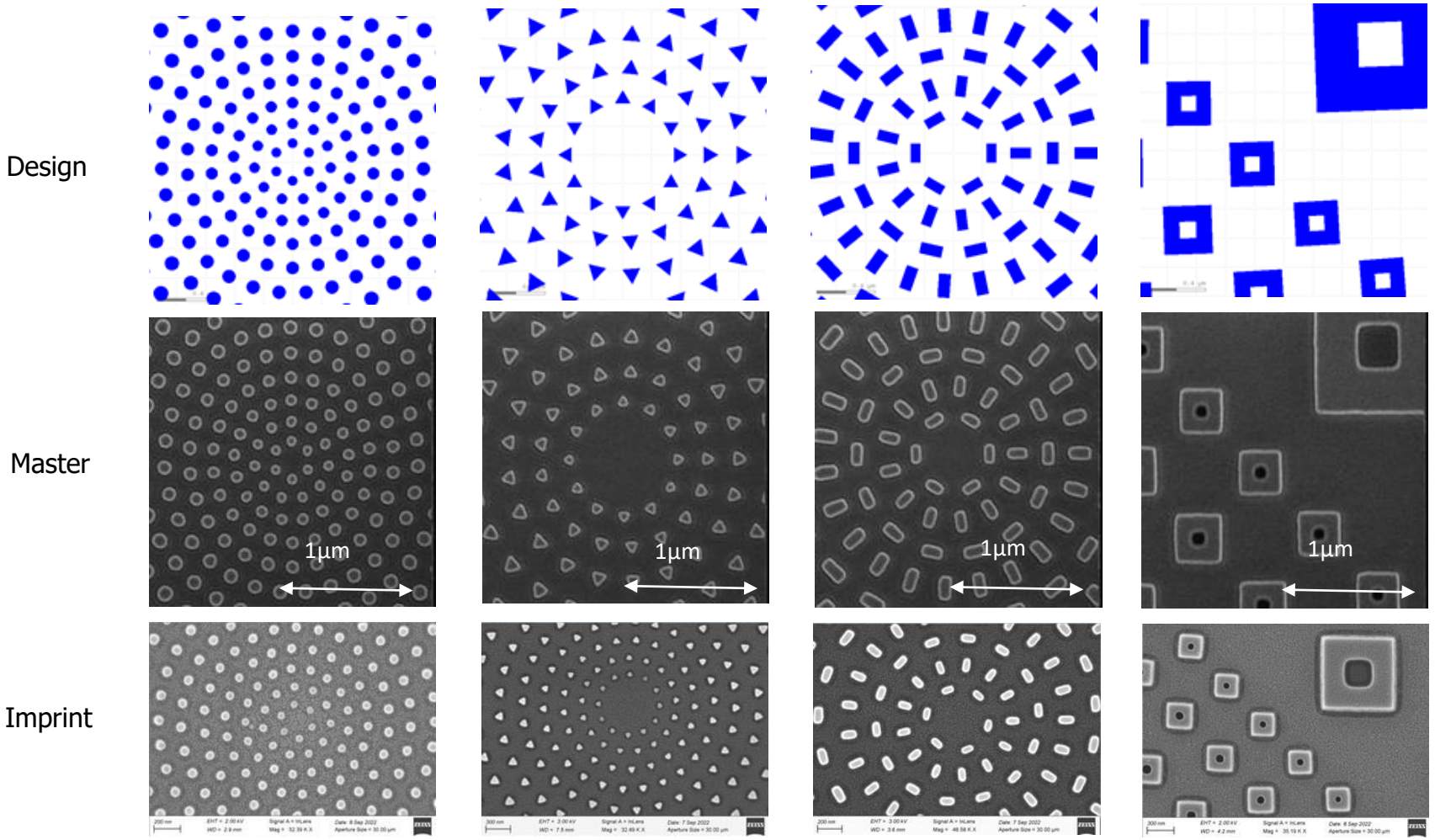
(maybe combined with slanted profiles)

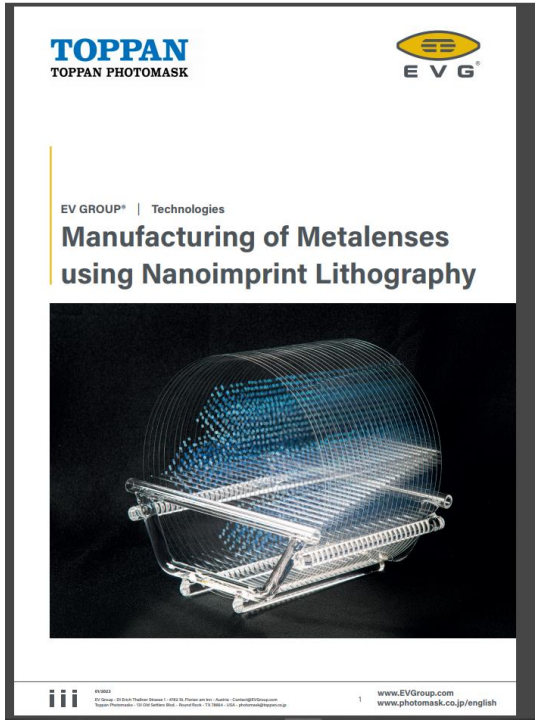



150nm 1:1 Lines/Spaces
(HM still on top)

# Meta-atoms of arbitrary Shapes

- NIL masters with meta-atoms of arbitrary shapes at high resolution can be manufactured
- NanoImprint can accurately reproduce these shapes by EVG tools




Joint White Paper Toppan & EVG illustrates availability of processes/tools for high-volume manufacturing of metalenses using NIL

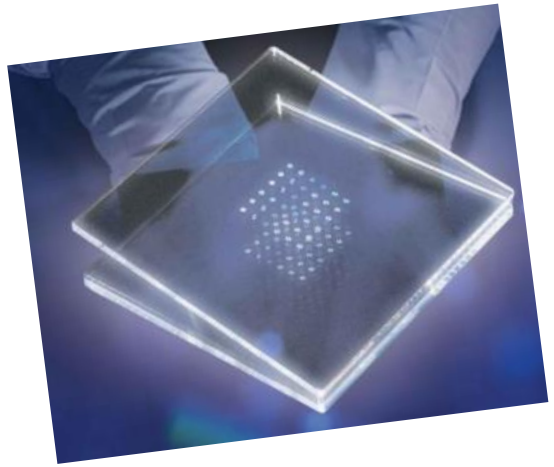
# Summary

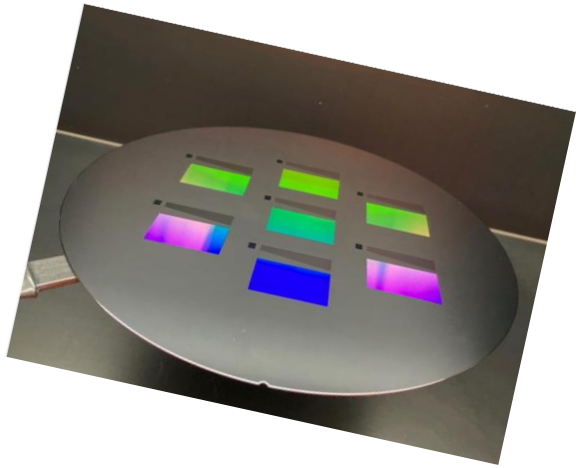
→ Photomask technology is well suited to manufacture NIL masters for advanced optical devices

Our Offer:

- Industrialized setup for prototypes and high-volume manufacturing of masters
- Excellent understanding & implementation of special requirements of NIL masters
- Access to high production and e-beam capacity
- Tightly controlled manufacturing processes and defect-free environment

- 6” square Quartz and 8” round Silicon form factors





TOPPAN

TOPPAN PHOTOMASK

**Toppan's industrialized, state of the art technology will bring Your cutting-edge products into reality**

**We look forward to a Bright Future with you**

For more information, please contact us

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Email: photomask@toppan.co.jp