Enabling High-Precision Optics in Consumer Devices with 3D Microfabrication

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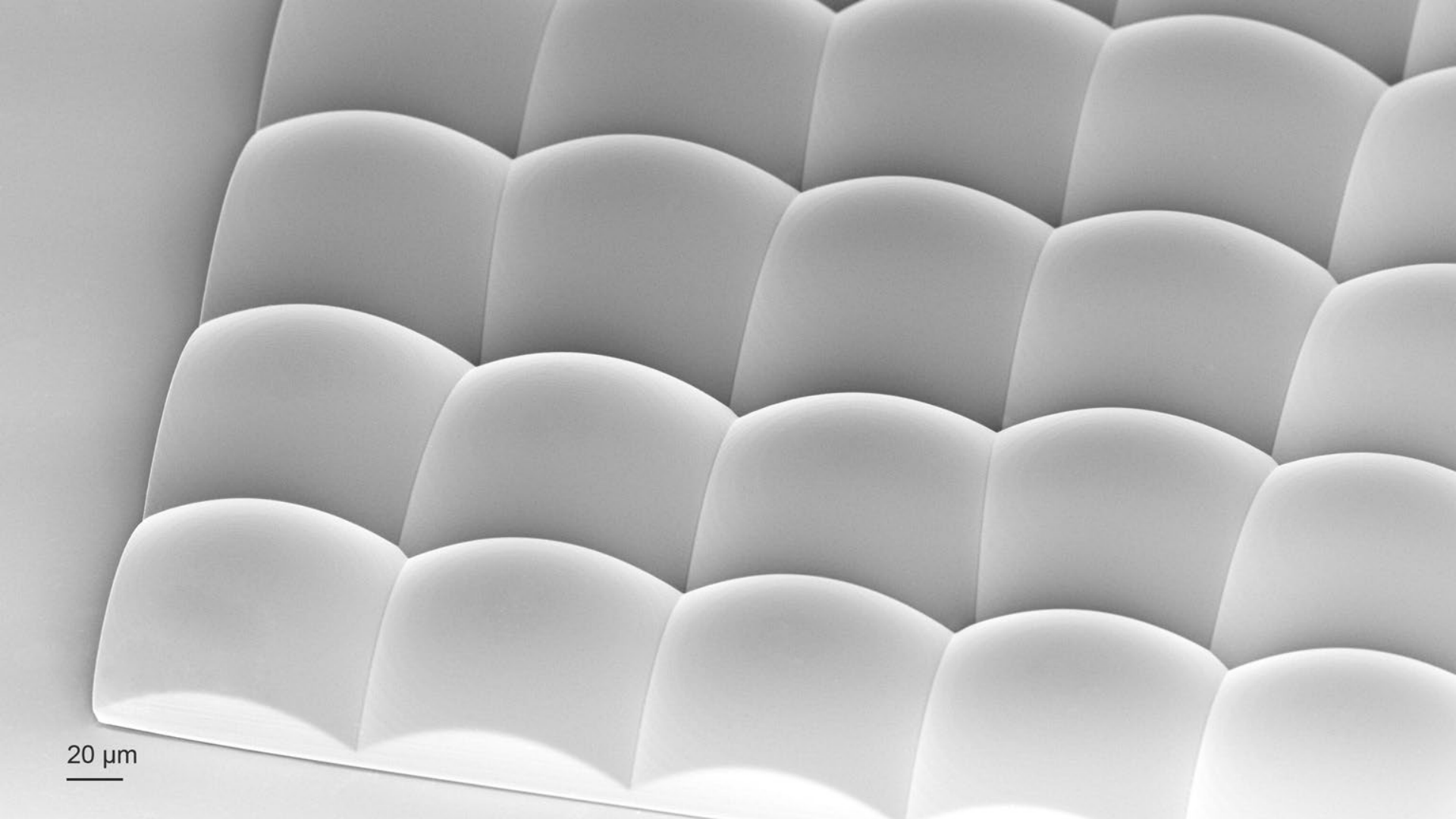
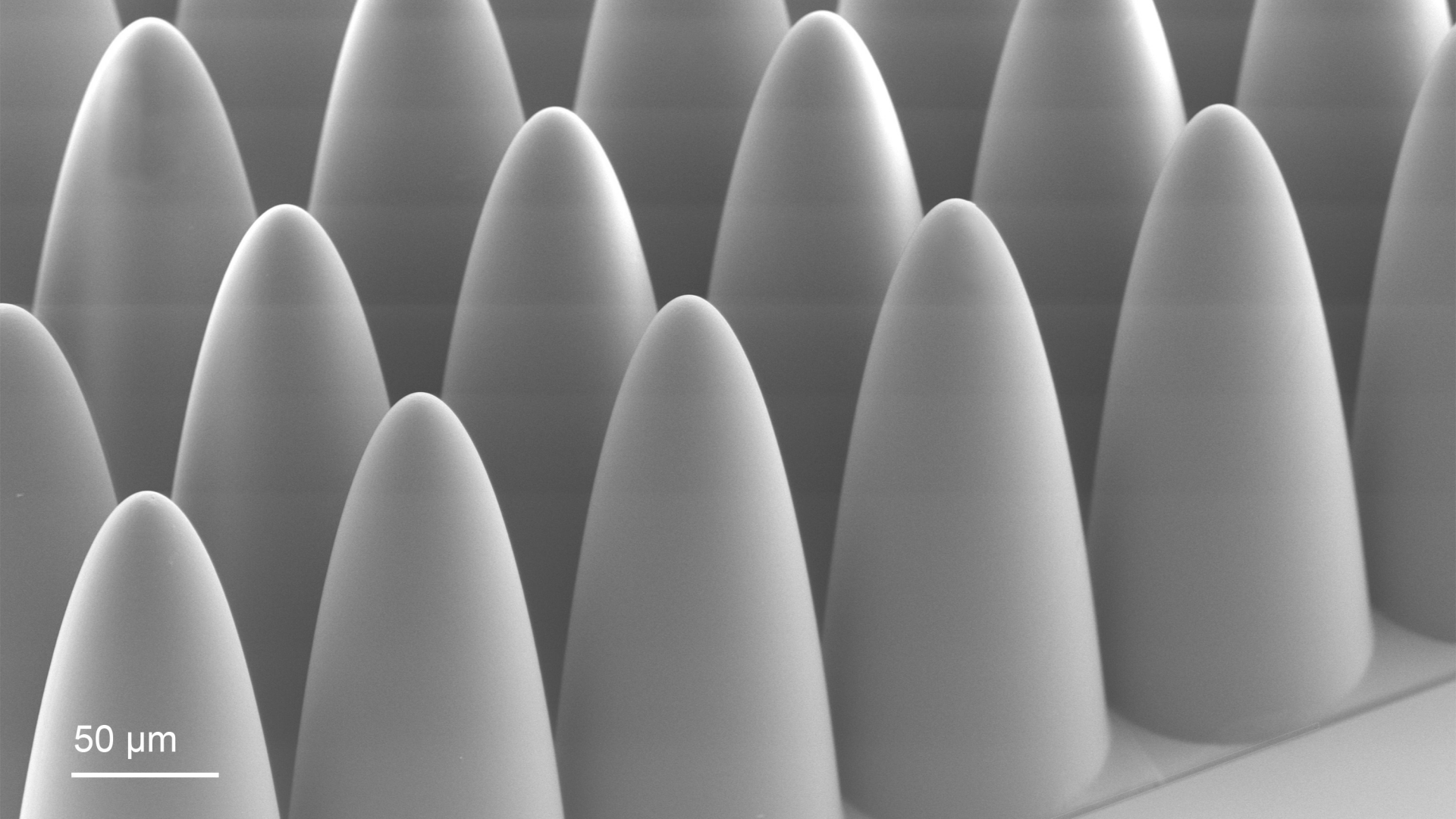
Micro Optics Summit

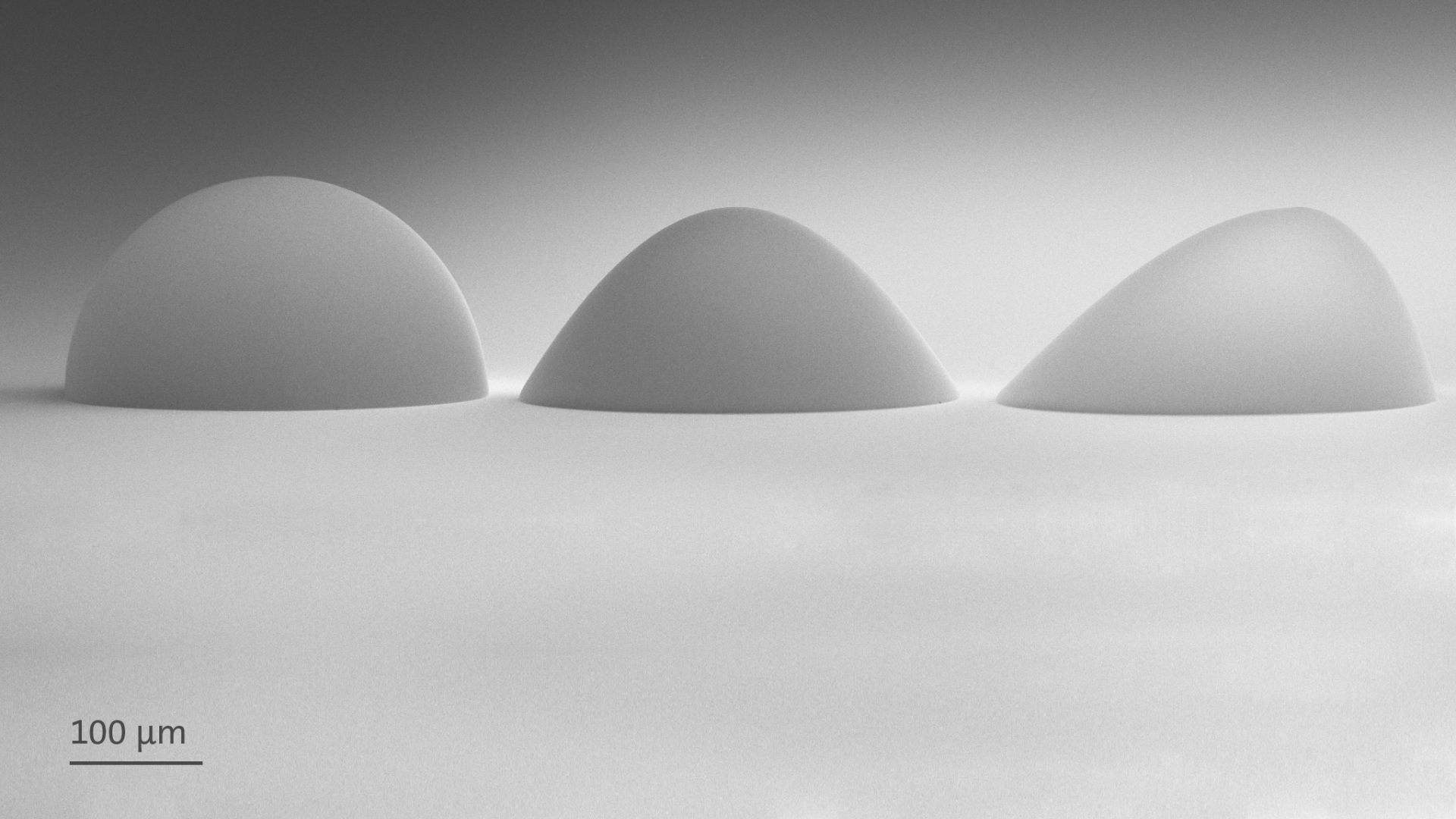
MEMBER OF GROUP | LAB14

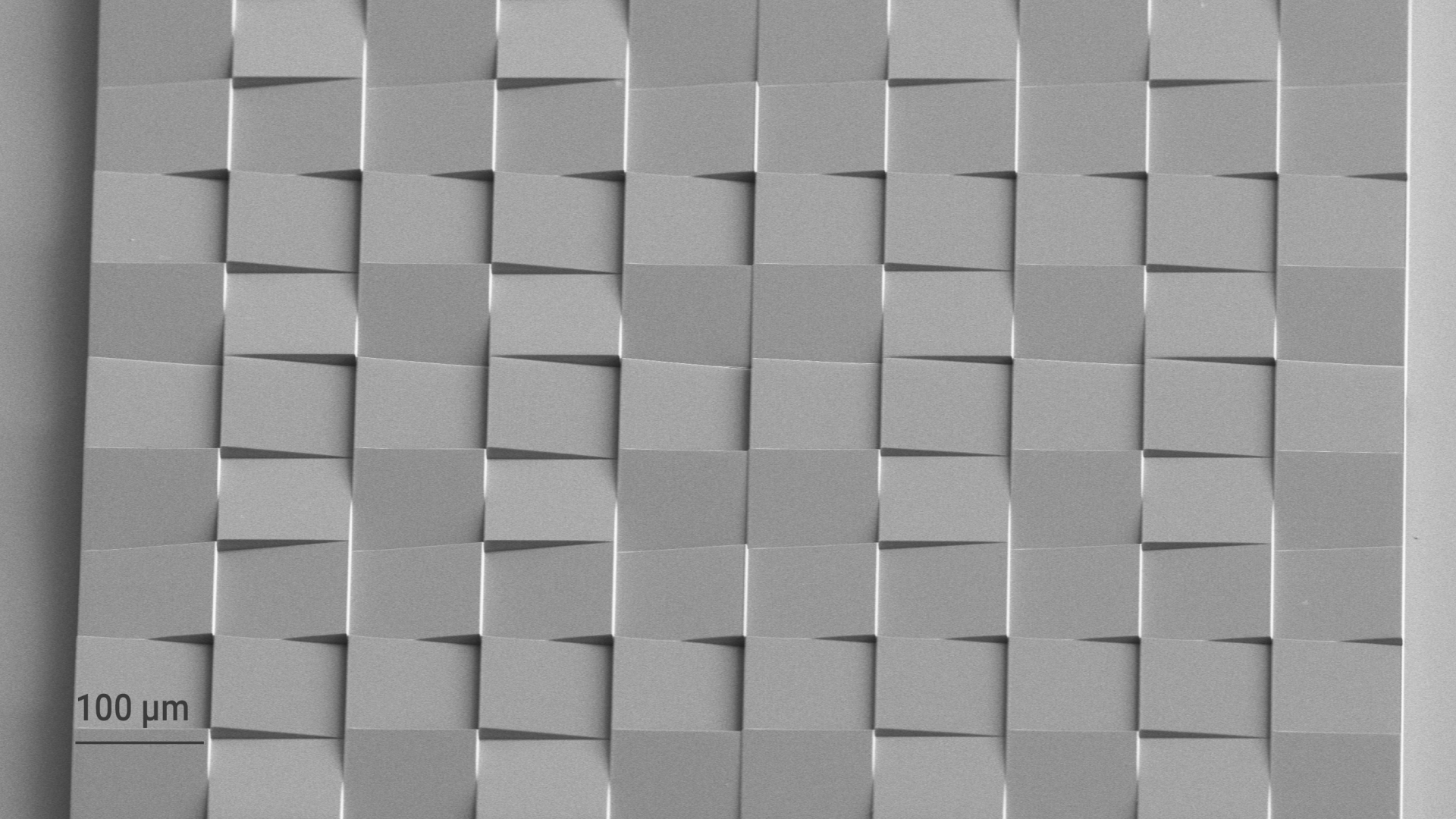
Company Facts & Figures

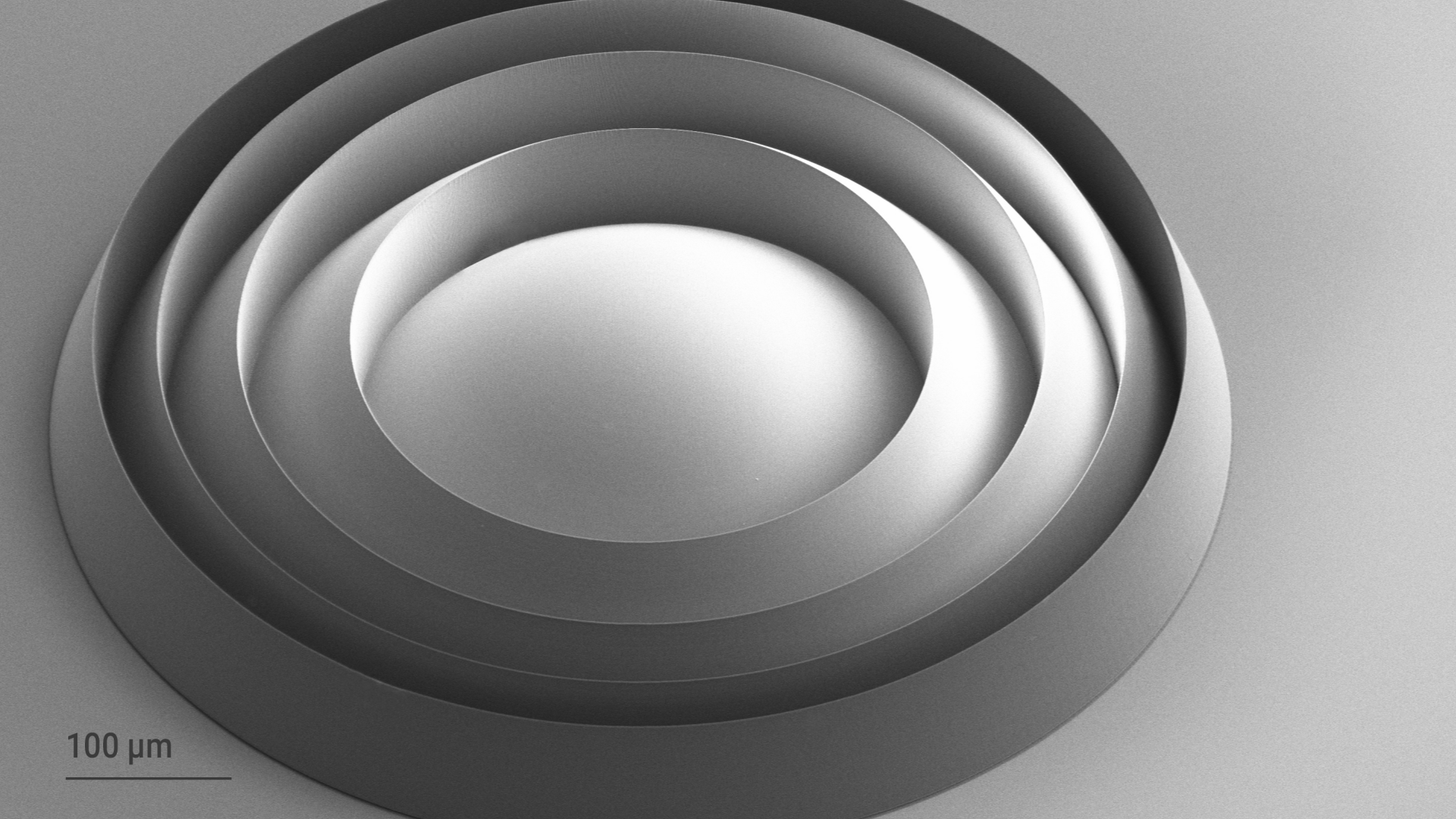
- 100+ employees
- 35% R&D intensity
- 4,000+ users
- 2,000+ publications
- HQ in Karlsruhe, Germany with >4,200 m² space
- Subsidiary Boston, US
- Subsidiary Shanghai, CN
- 17+ years of success

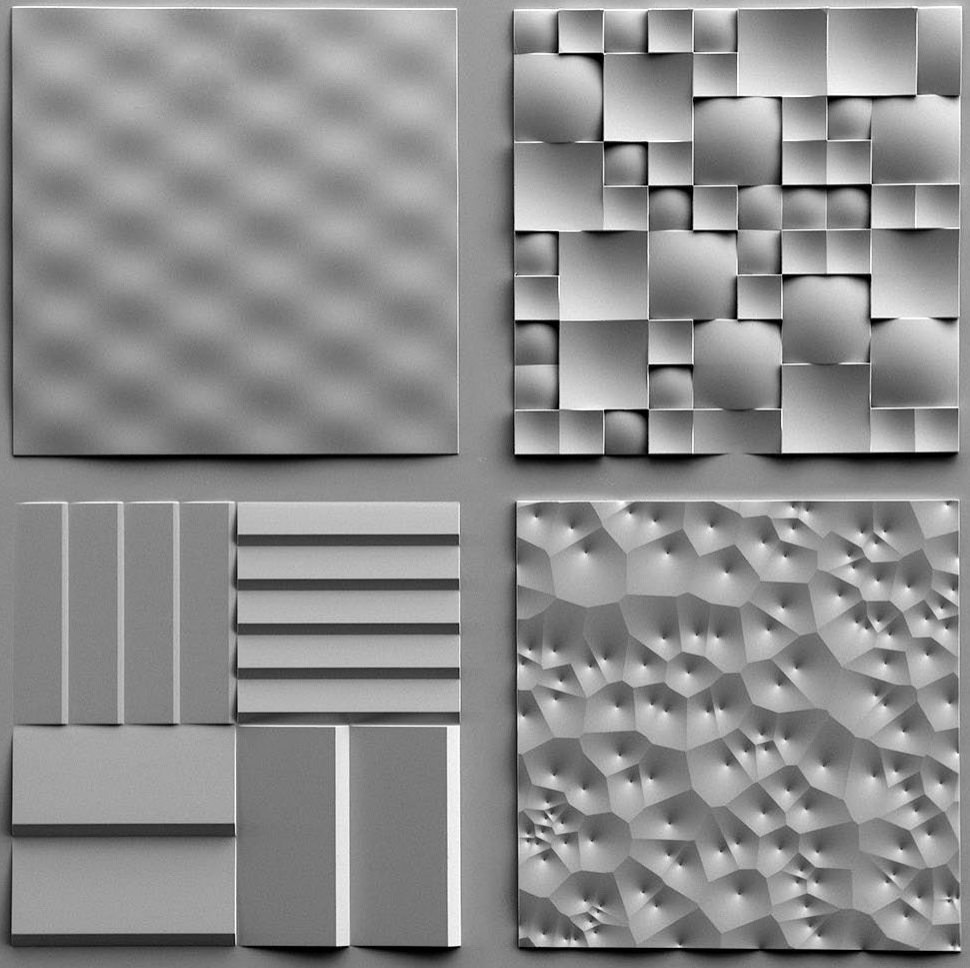

20 µm

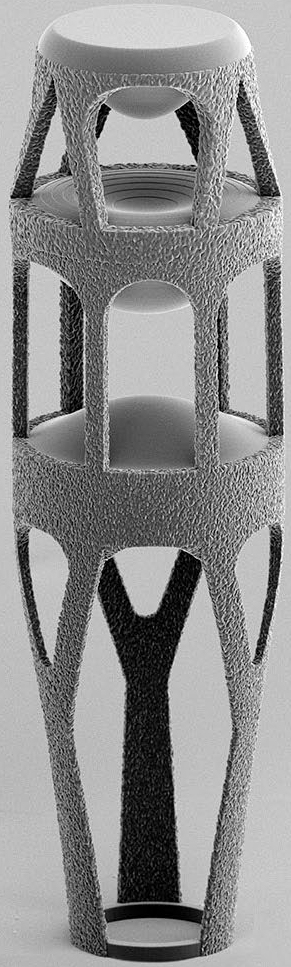

50 µm


100 µm


100 µm

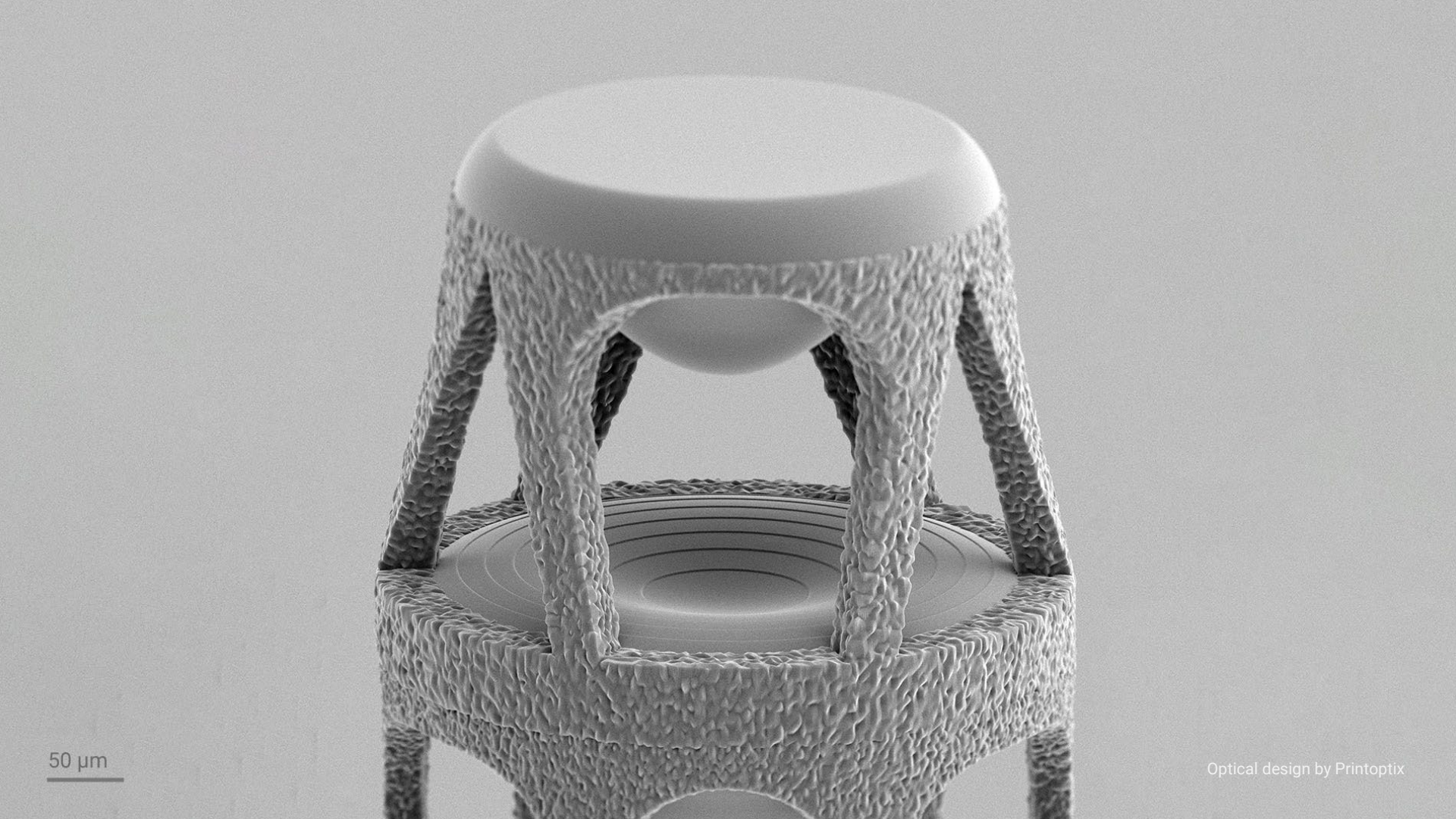

100 µm

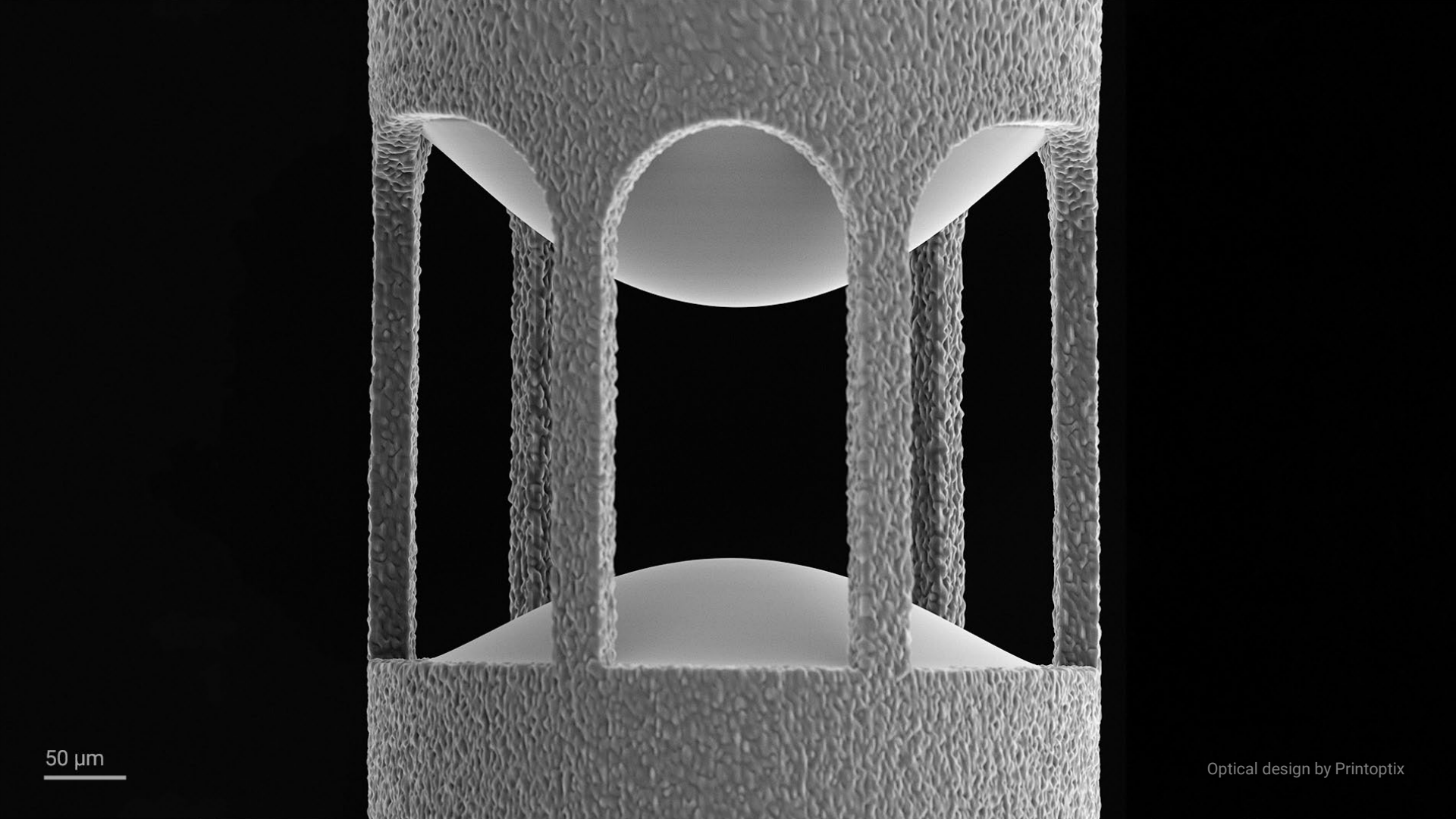

500 µm

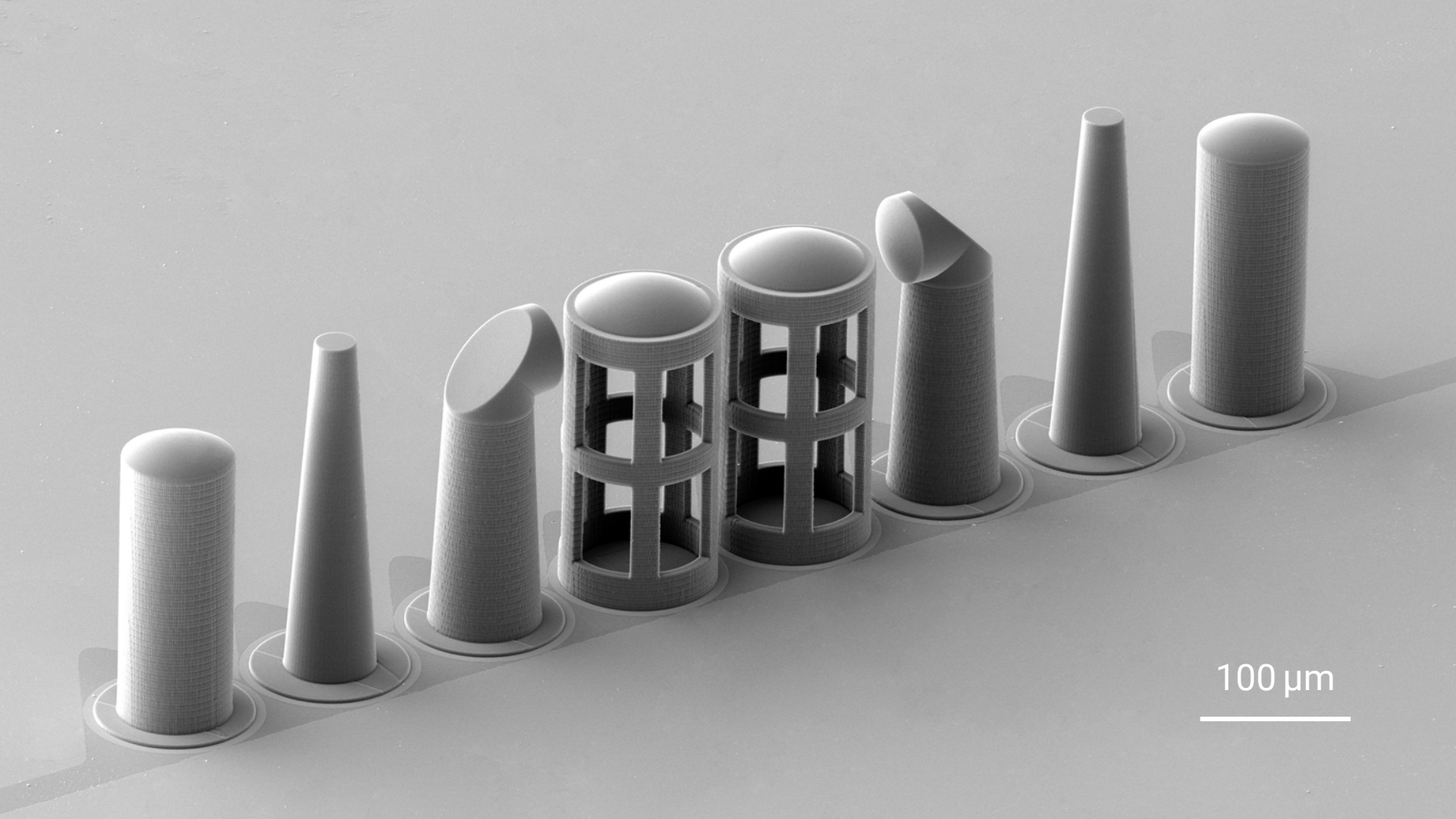


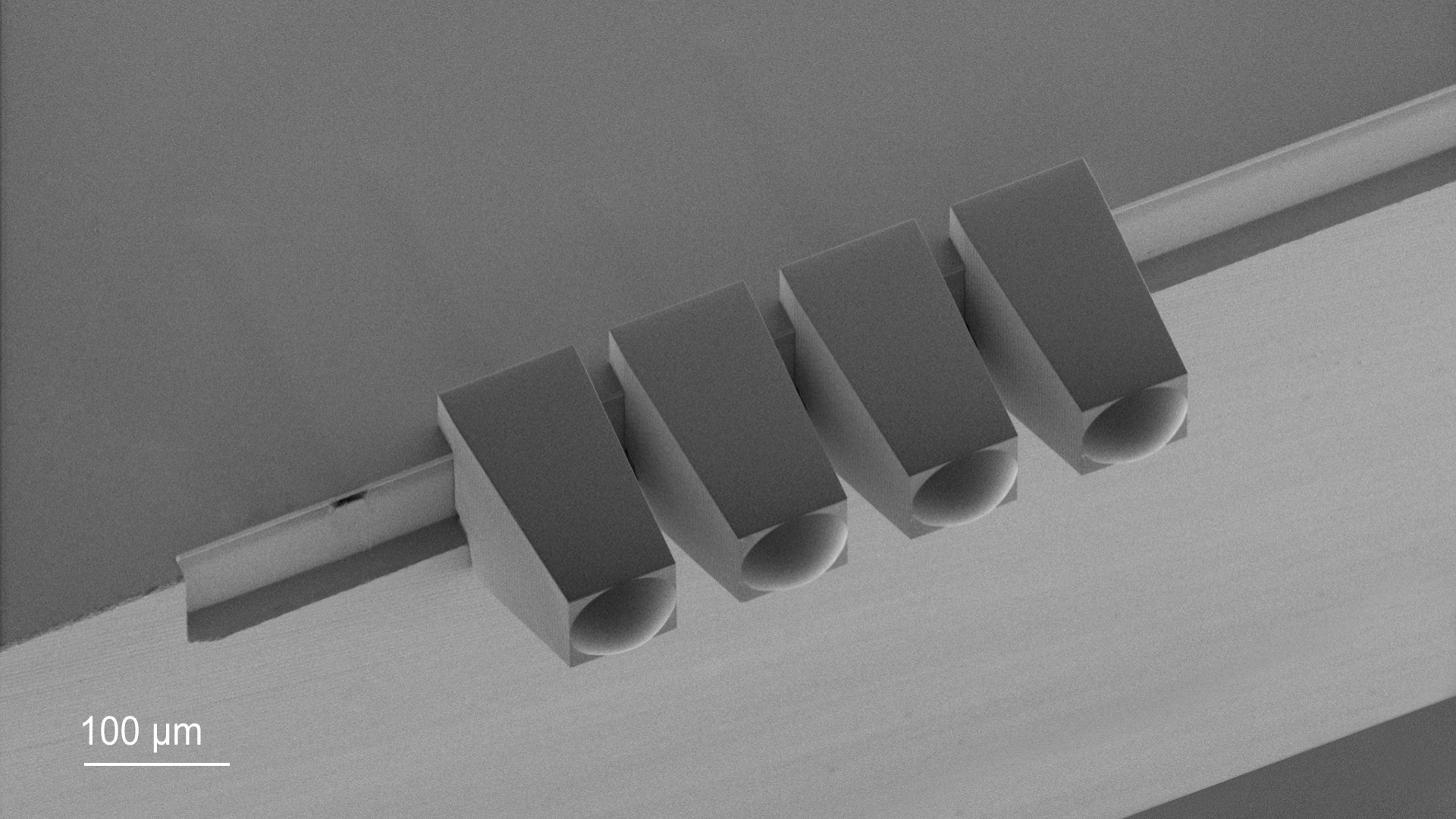
200 µm

Optical design by Printoptix


50 µm
Optical design by Printoptix


50 µm
Optical design by Printoptix

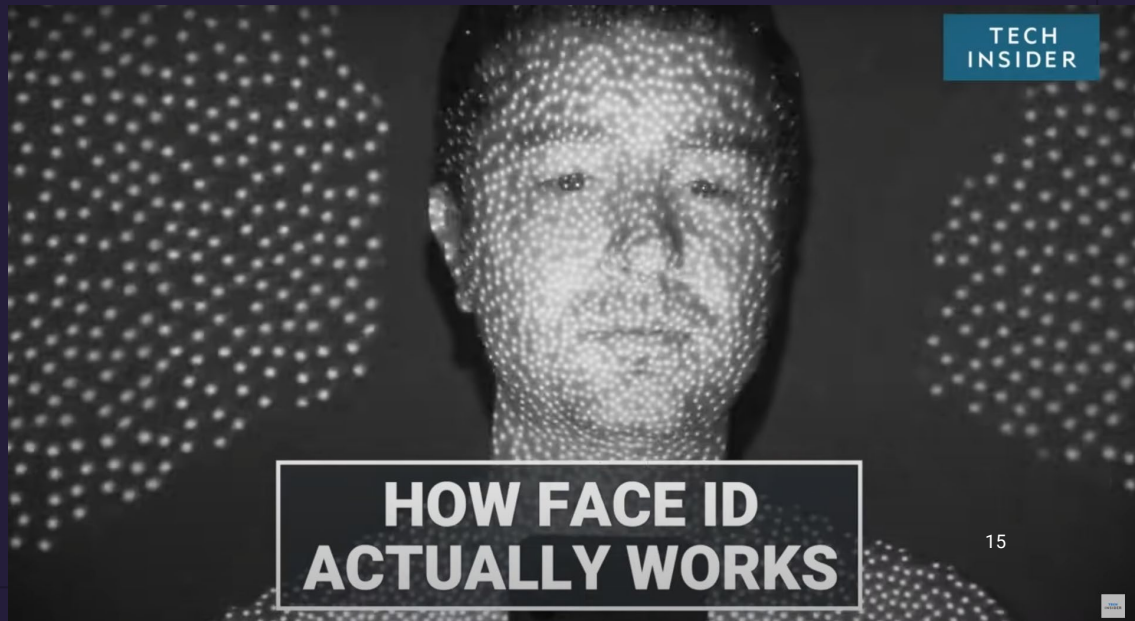

100 µm


100 µm

nano scribe
A BICO COMPANY

Grid Projection

Laser spot grid projection has important applications for 3D depth sensing, lidar, and so on.



Diffractive optical elemens

- Digital design workflow for diffractive optical elements
- New design paradigm: Continuous designs without steps or squared pixels

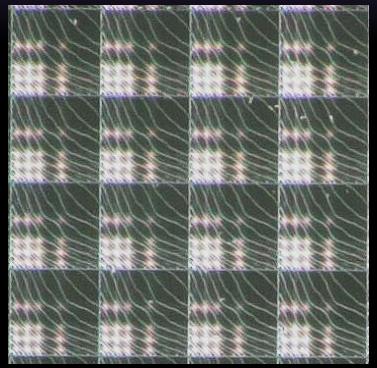
Design by

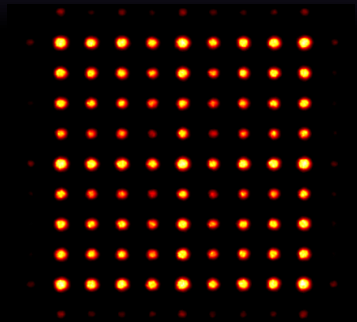
LIGHTTRANS

DOE for 9x9 dot grid projection

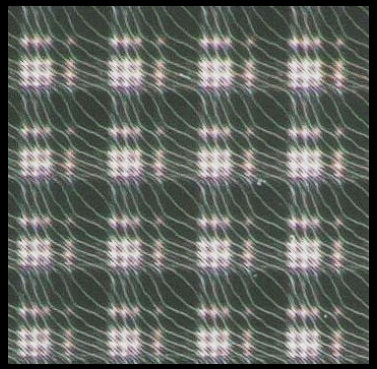
100 µm

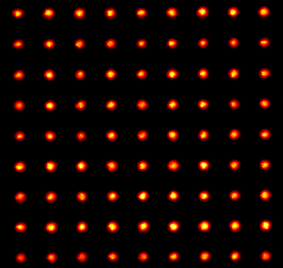
No tilt compensation





Tilt compensation





Prototyping and Mastering of a Beam Homogenizer

Design freedom outperforms current standards

Refractive beam diffuser based on random MLA

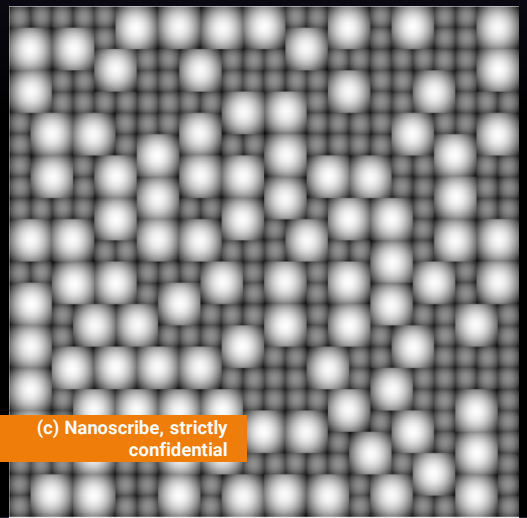
- Design files exported to grayscale 16-bit PNG images with a pixel size of 200nm
- Base unit 1.8 mm wide was repeated in a 3x3 array to create a 5.4 mm diffuser.

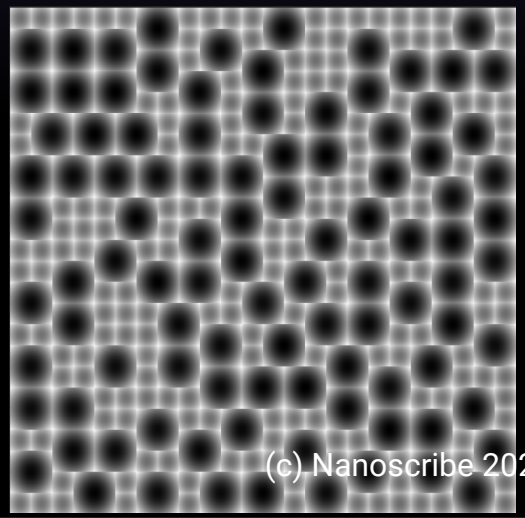
Convex (standard)

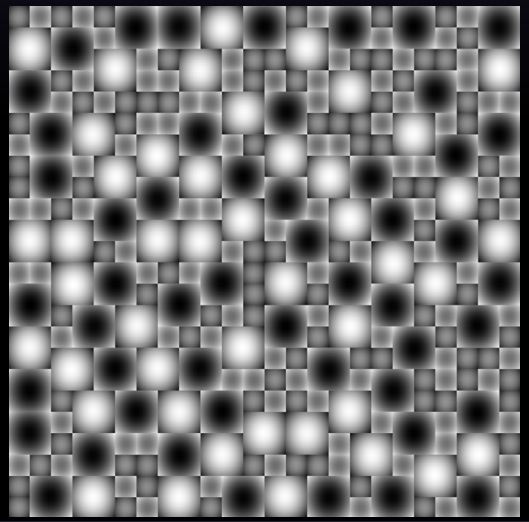
Concave

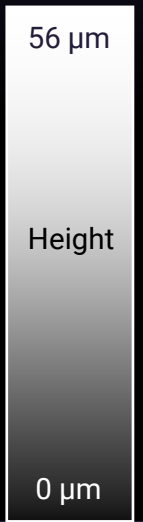
1.8 mm (base unit)

Mixed





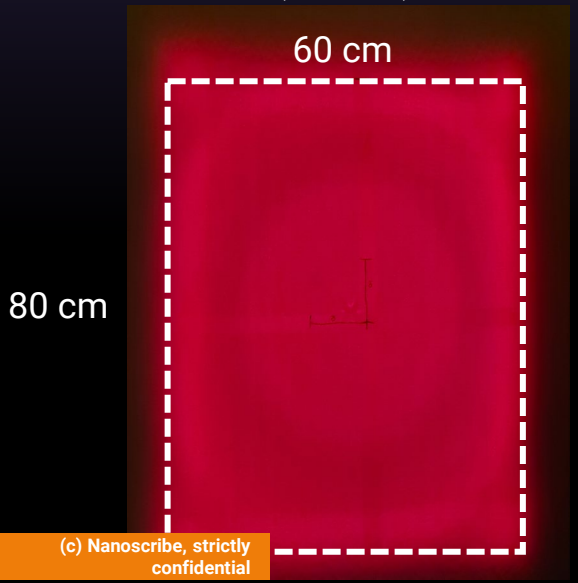




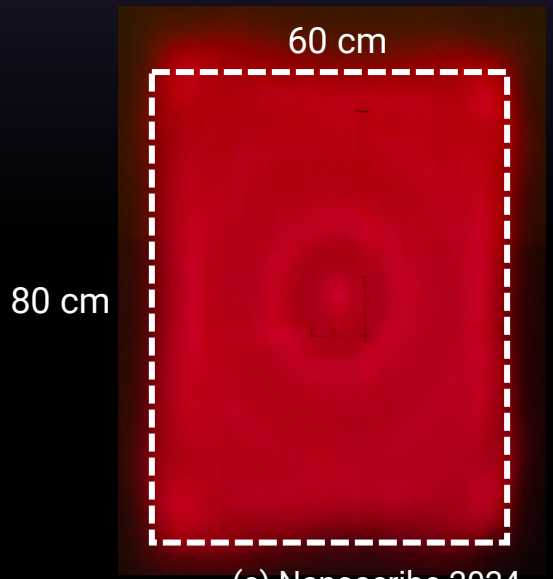
Refractive beam diffuser based on random MLA

- Experimental results

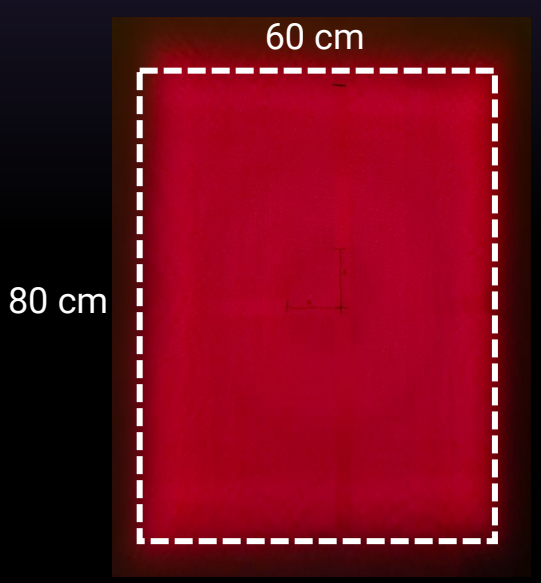
Convex (standard)

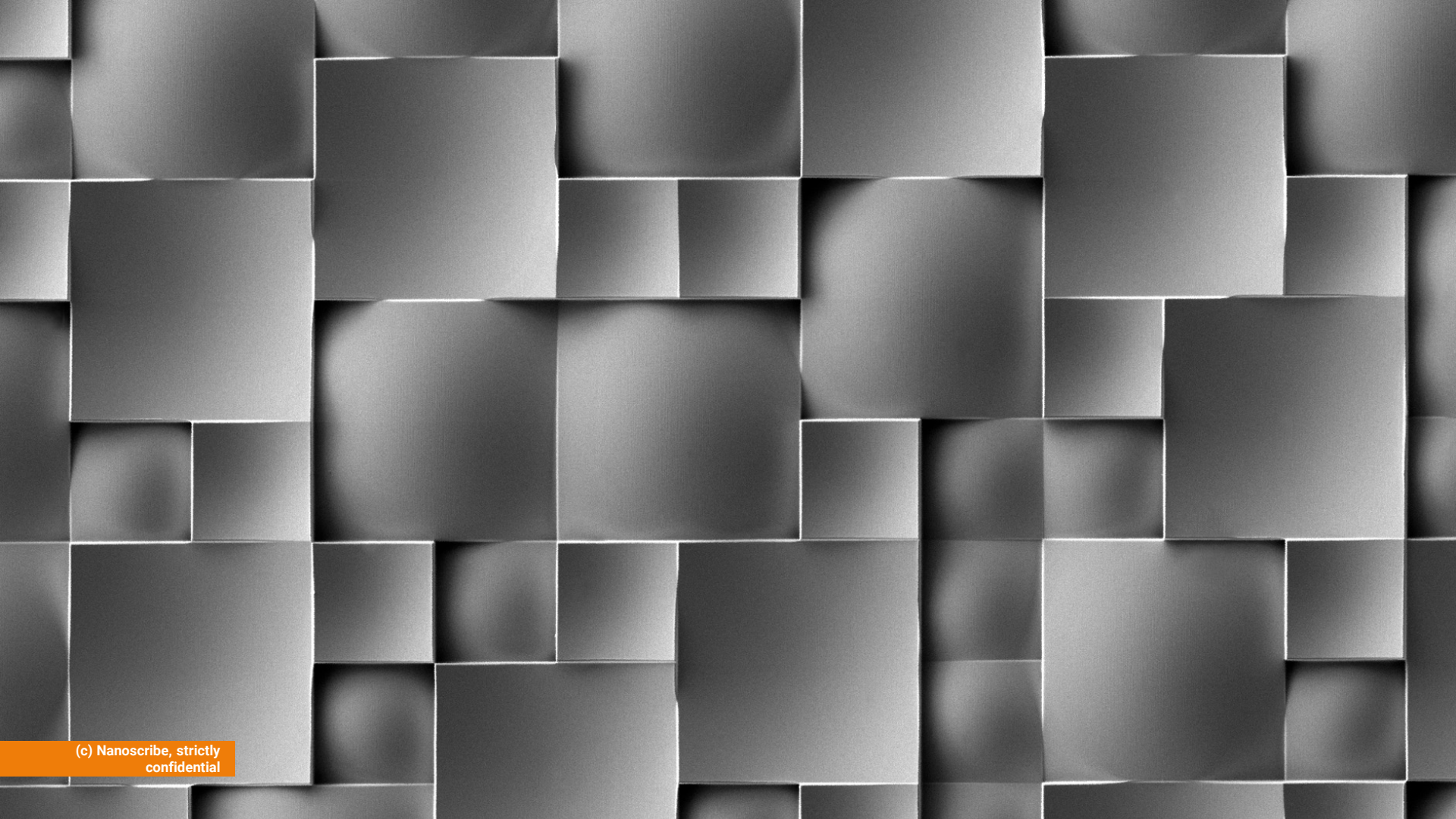


Concave



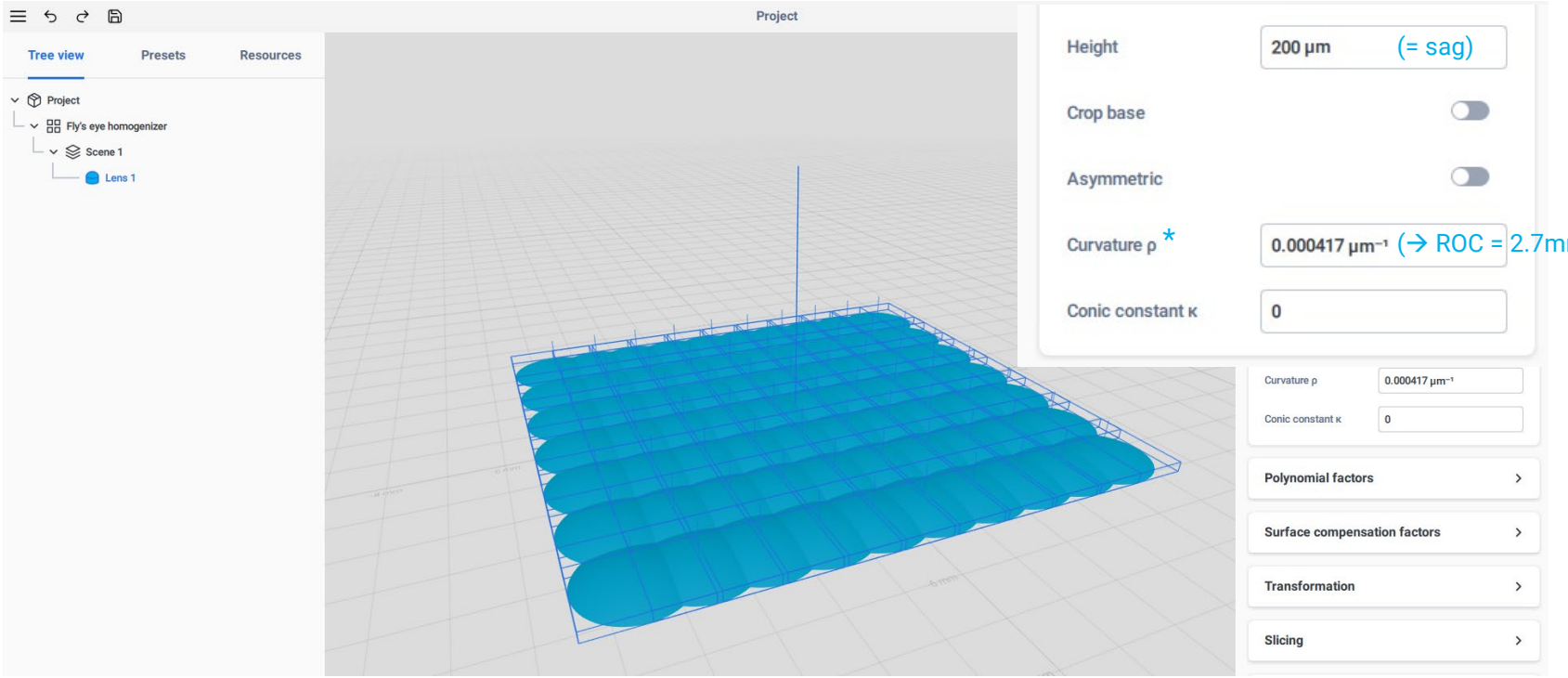
Mixed





Fly‘s Eye Homogenizer

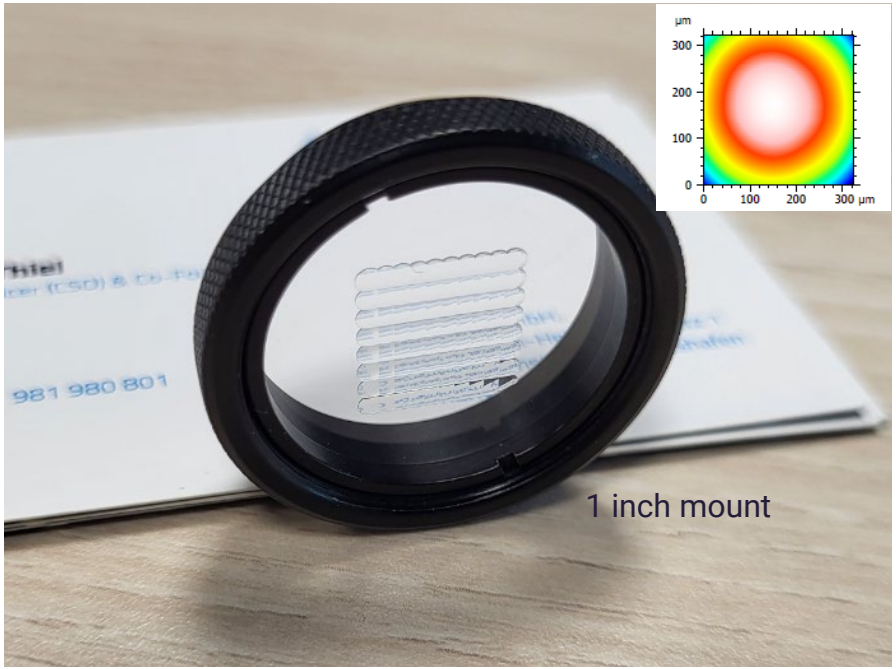
Software: Fly‘s eye homogenizer



*Note that there is a complete freeform capability of the process

Print: Fly‘s eye homogenizer

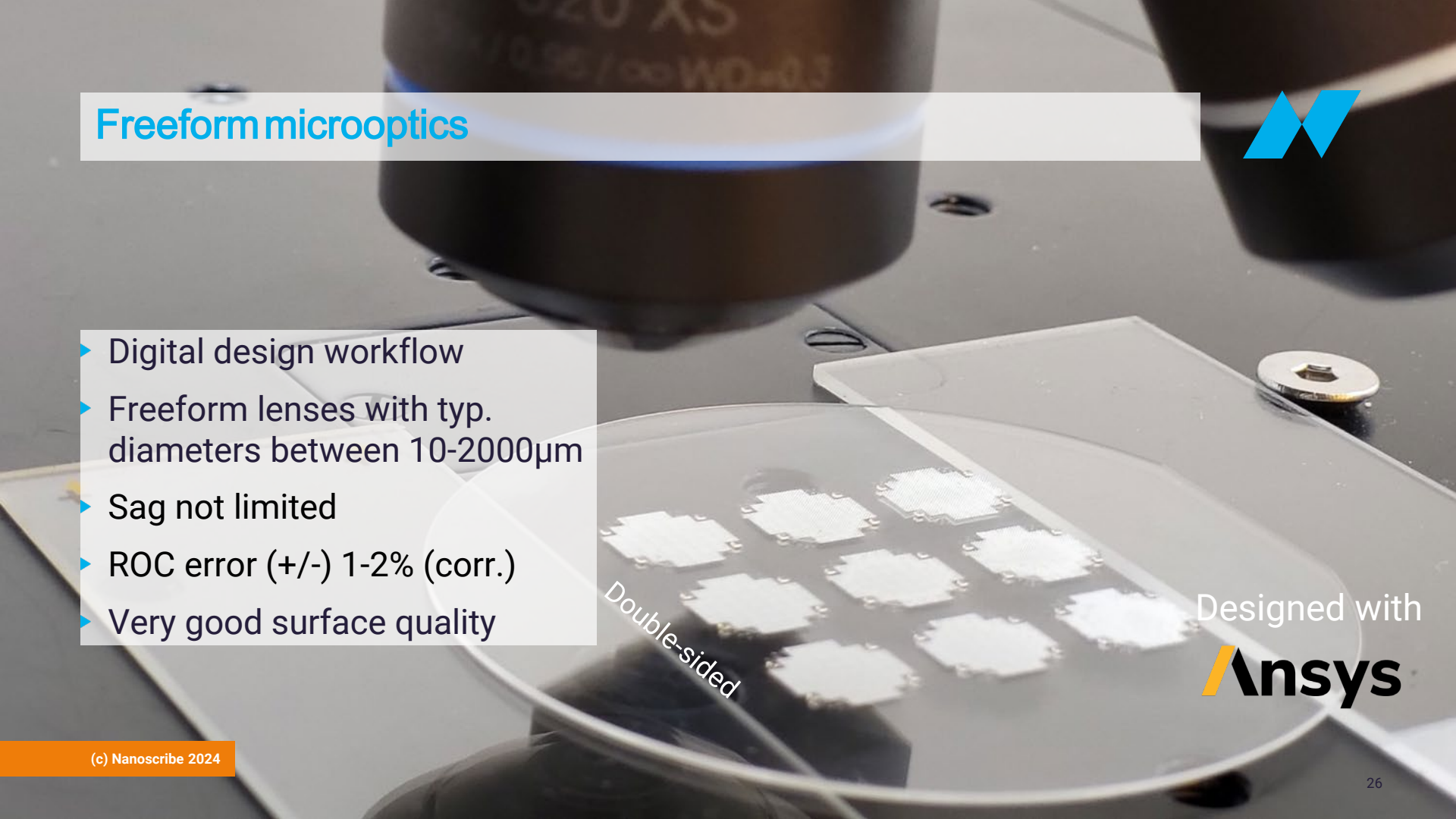
- Array Size: 10.0 mm x 9.8 mm x 0.37mm
- Array Type: Rectangular Grid
- Polymer: Nanoscribe
- Substrate: borosilicate glass
- Lenslet Pitch: 1.0 mm x 1.4 mm
- Lens sag: 0.2 mm
- Conic constant: 0 (RMS <150nm)
- Radius of Curvature: 2.7 mm (+-3%, uncorr.)
- Surface roughness: <10 nm



Double-sided MLAs

Freeform microoptics

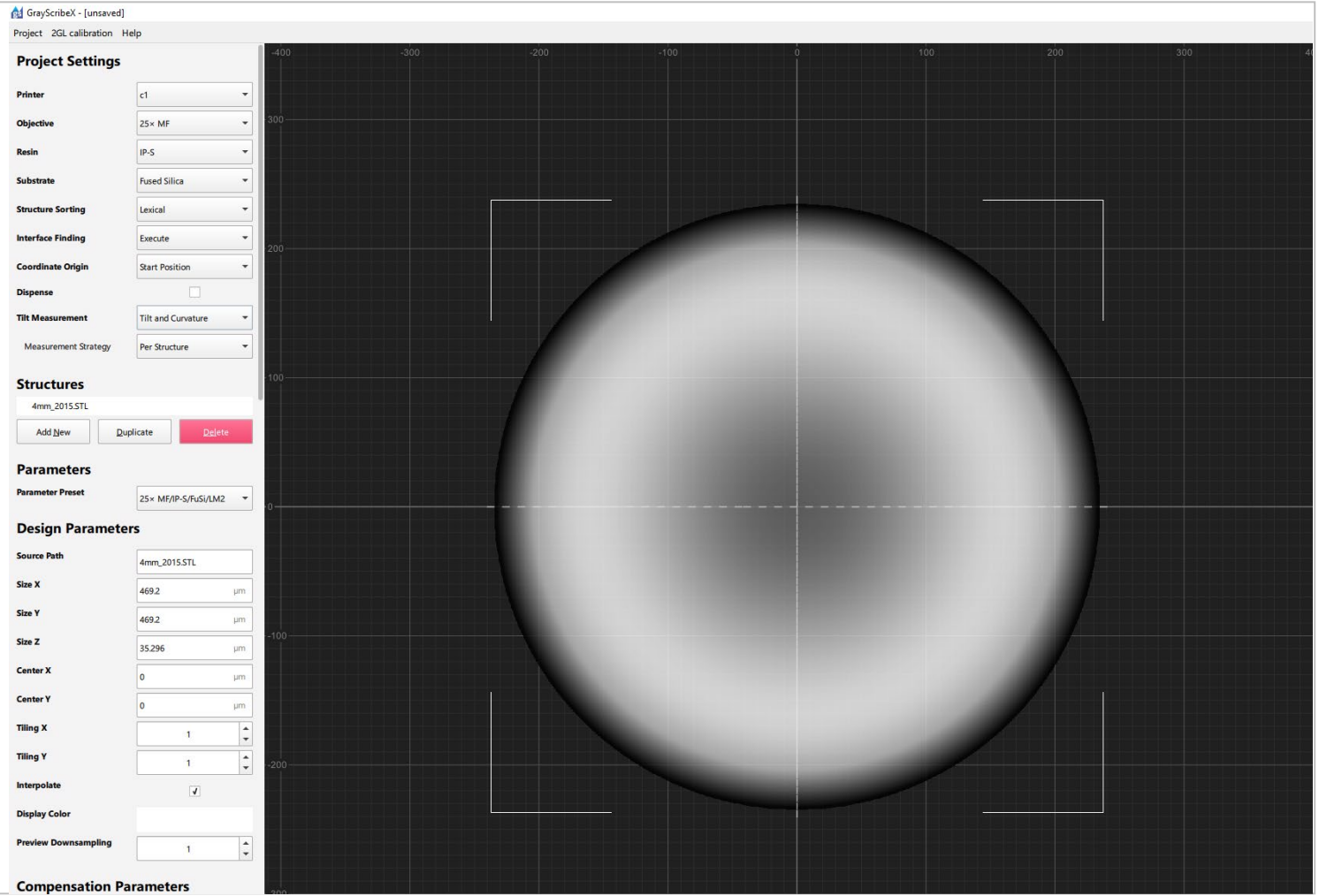
- Digital design workflow
- Freeform lenses with typ. diameters between 10-2000µm
- Sag not limited
- ROC error (+/-) 1-2% (corr.)
- Very good surface quality

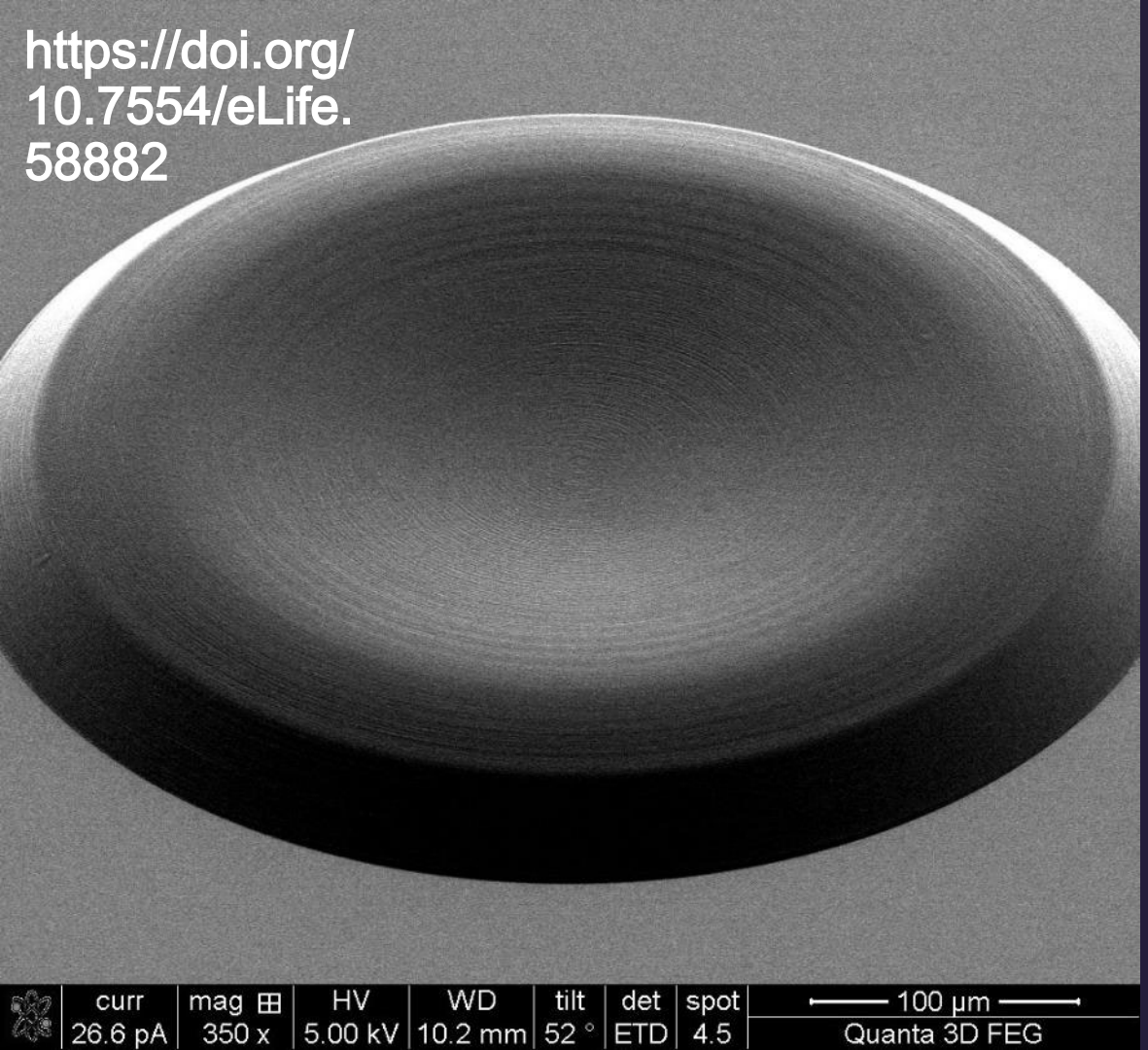


Designed with Ansys

2GL– Quality and Speed

GrayscribeX





Optimized fabrication

2017

12 hours
Barely decent surface quality (100nm Ra)

slicing (0.05 µm)
hatching (0.5 µm)
contour printing
12 shell layers.

جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

QuantumX
25x MF set 2GL

Quiz time

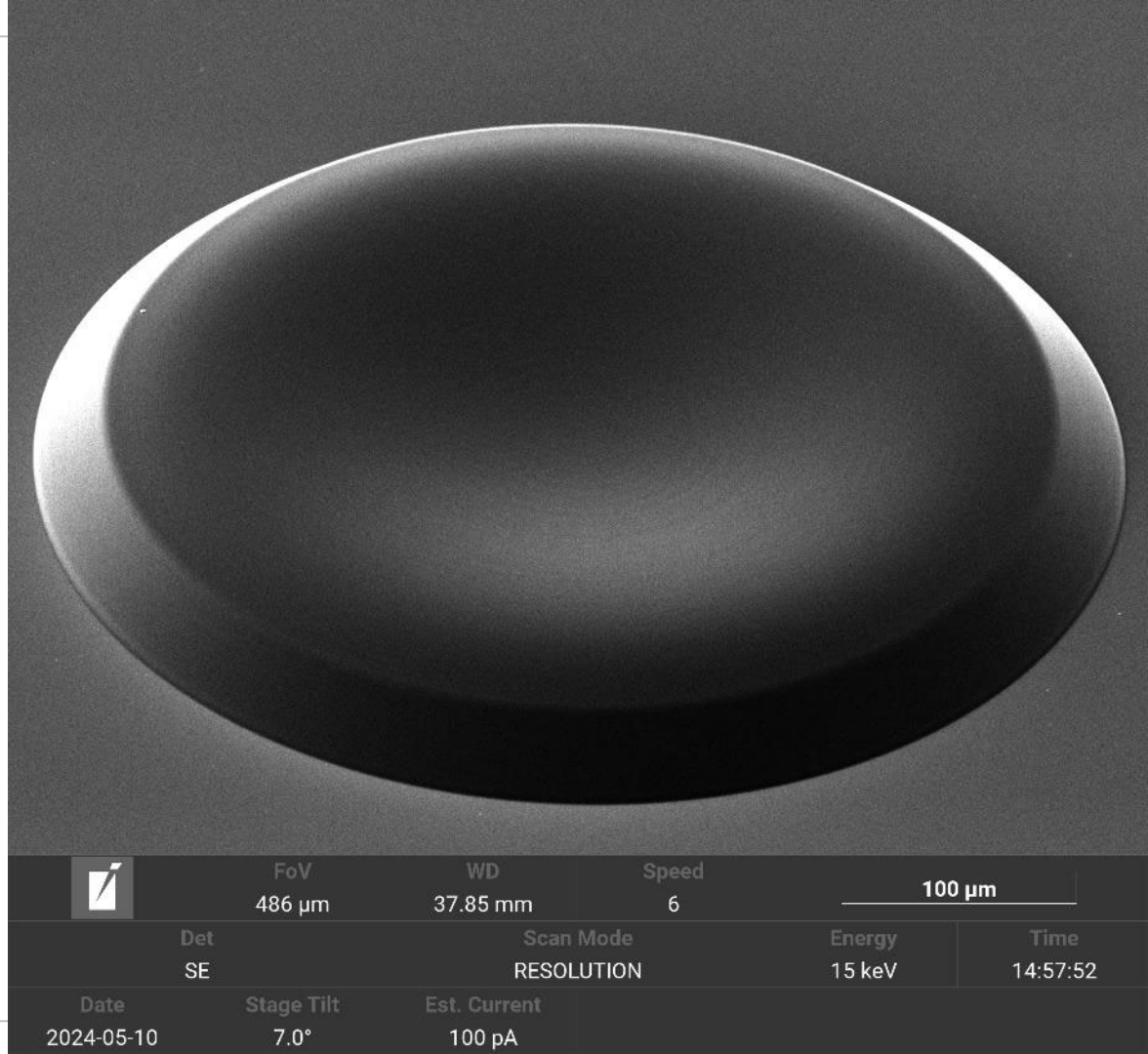
- A = 6 hours (2x)
- B = 1 hour (12x)
- C = 5 minutes (144x)
- D = 2 minutes (360x)

QuantumX
25x MF set 2GL

Quiz time

- ~~A = 6 hours (2x)~~
- ~~B = 1 hour (12x)~~
- C = 5 minutes (144x)
- ~~D = 2 minutes (360x)~~

Ra<10nm

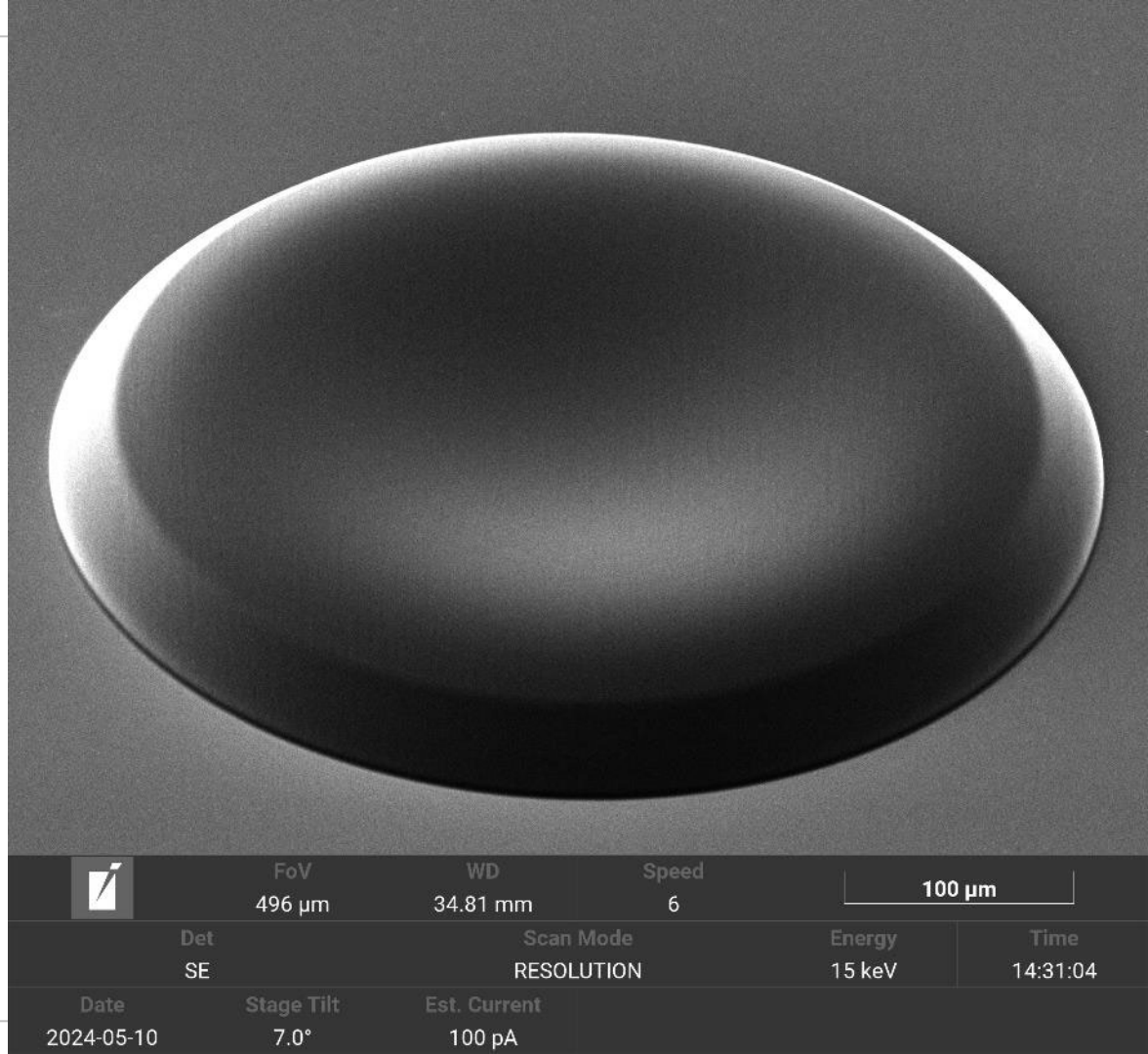


QuantumX
10x LF set 2GL

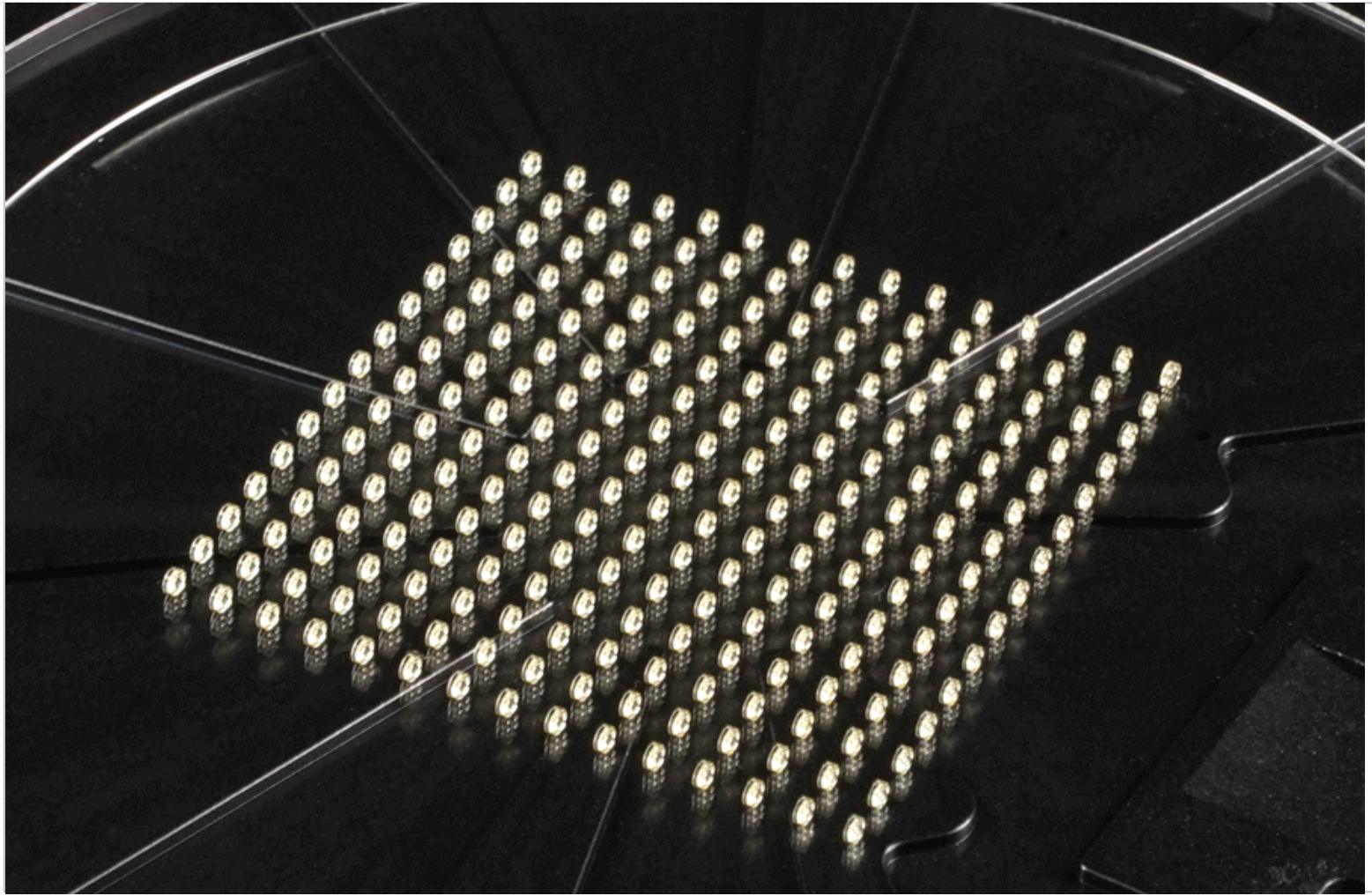
Quiz time

- ~~A = 6 hours (2x)~~
- ~~B = 1 hour (12x)~~
- ~~C = 5 minutes (144x)~~
- D = 2 minutes (360x)

Ra<20nm



Production Runs



Replication of Microoptics

Mass fabrication based on 2PP printed masters:

Nano Imprint lithography (NIL) & Injection Molding (IM)

Masters andmolds

- Masters for different replication techniques
- Injection molding
- Nanoimprint lithography allows for 8”-12” wafer replication

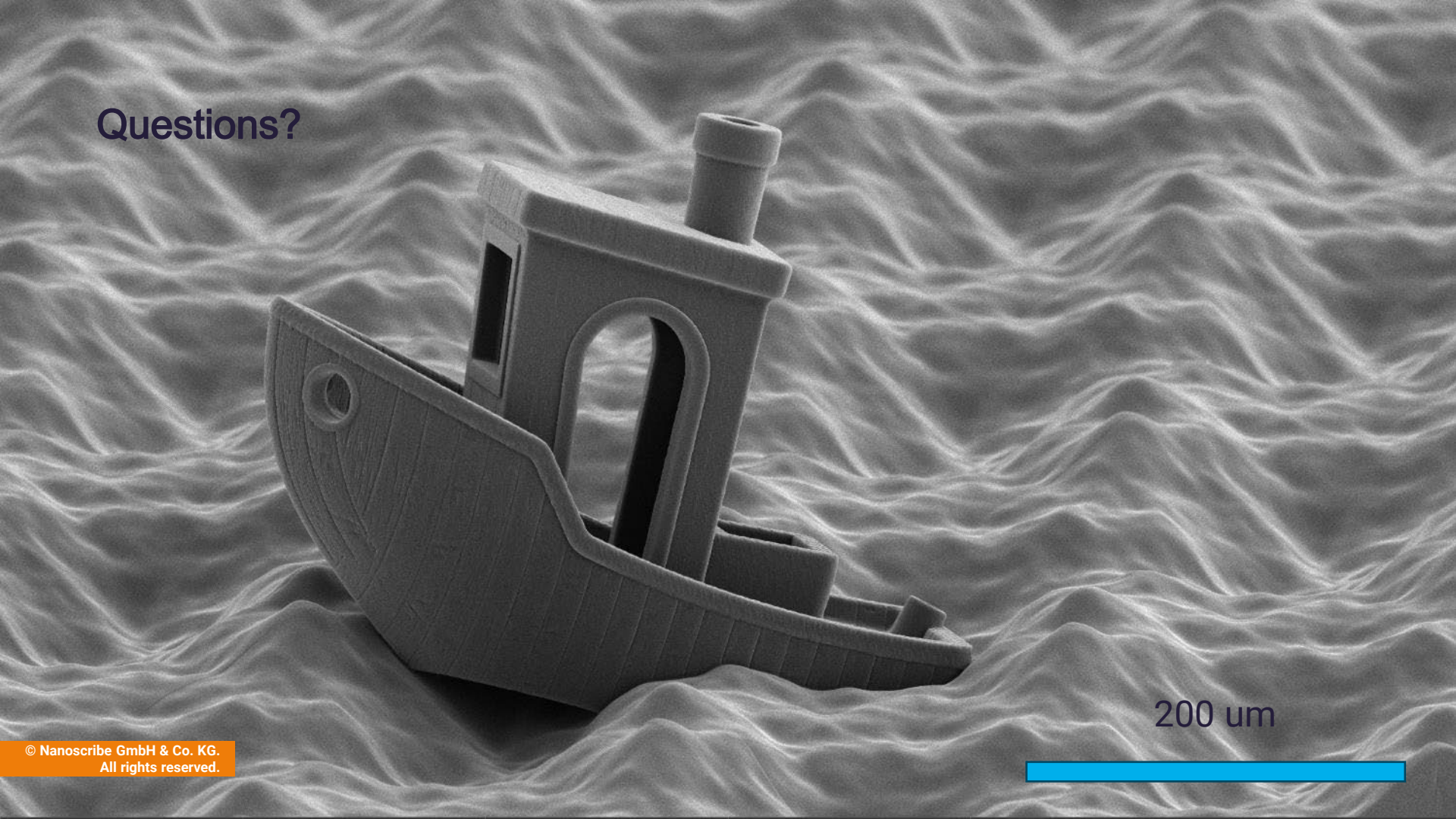
Partner:

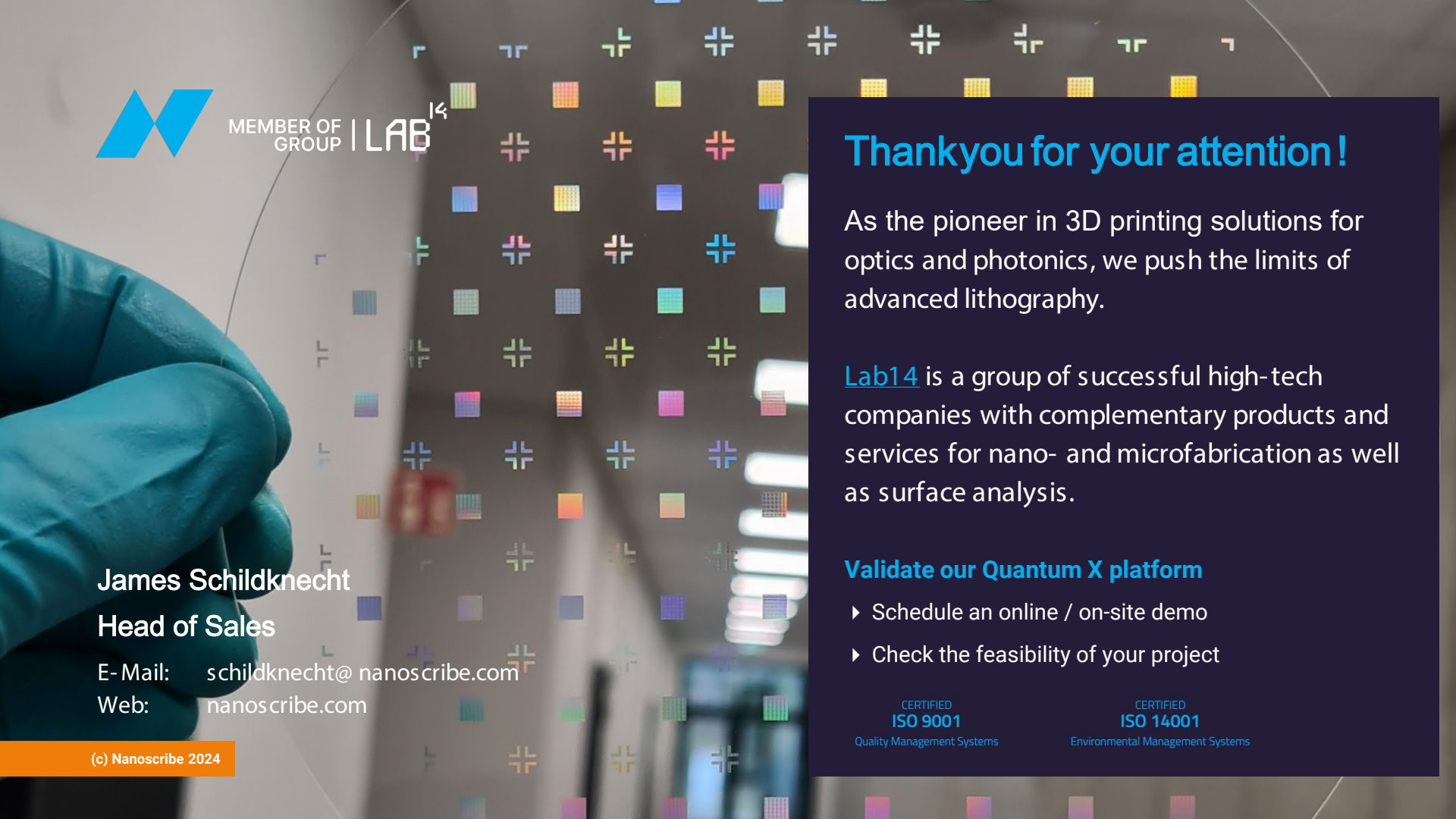
EVG

Replication processes
Injection Molding

- Beam homogenizer
- Injection molded replica
- Sprue and runner still attached
- Produced by our partner kdg

Questions?





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Thankyou for your attention!

As the pioneer in 3D printing solutions for optics and photonics, we push the limits of advanced lithography.

Lab14 is a group of successful high-tech companies with complementary products and services for nano- and microfabrication as well as surface analysis.

Validate our Quantum X platform

- Schedule an online / on-site demo
- Check the feasibility of your project

CERTIFIED ISO 9001 Quality Management Systems

CERTIFIED ISO 14001 Environmental Management Systems

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