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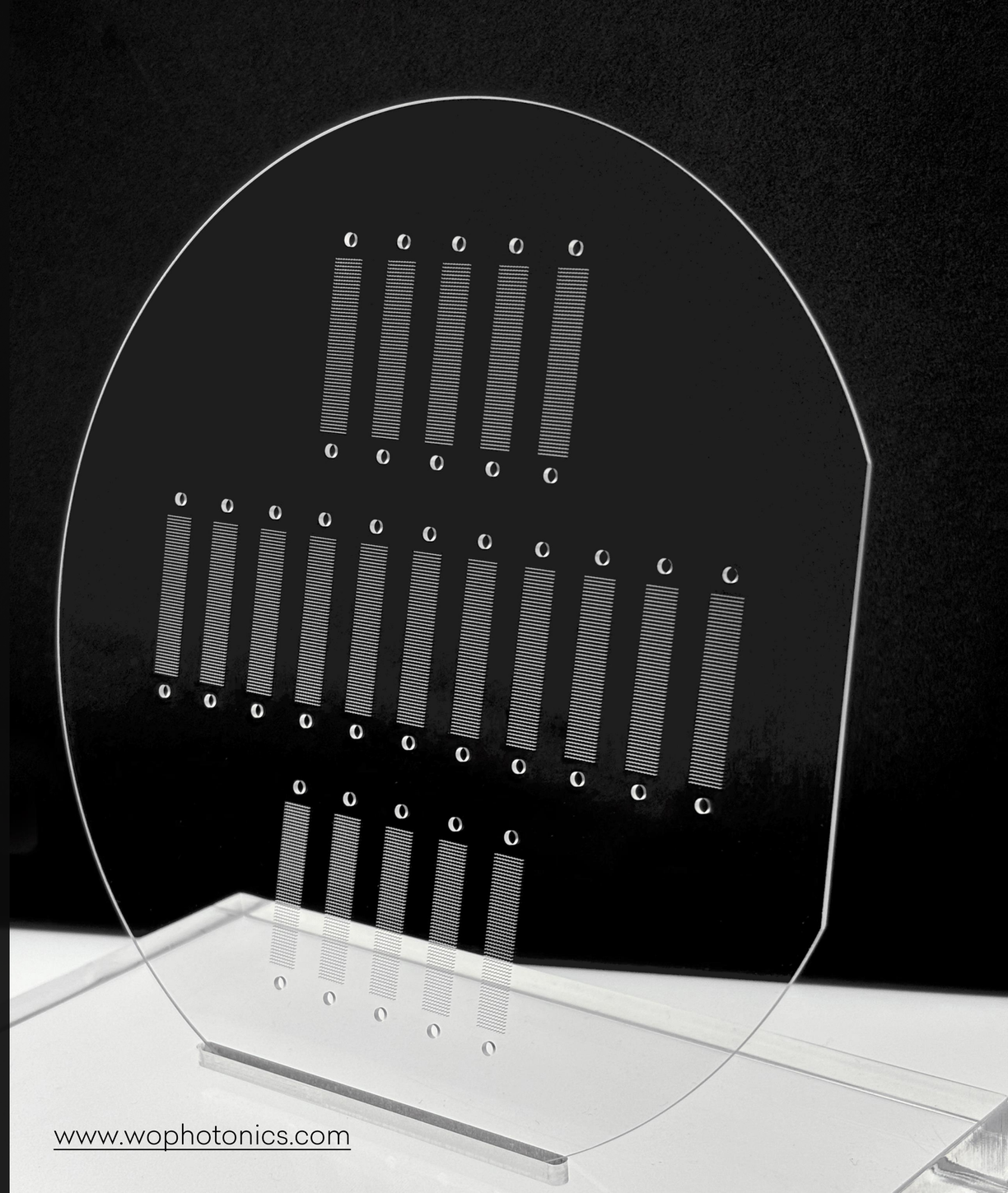
# Advanced SLE Techniques for Enhanced 2D Optical Fiber Alignment in Dense Data Transmission

**Aurimas Vrubliauskas**
Technical Project Manager

Event hosted by:

EPIC
EUROPEAN PHOTONICS INDUSTRY CONSORTIUM



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# We deliver **solutions** for **your μ tasks**

## 20 years of expertise

in femtosecond laser micromachining with a high focus on glass

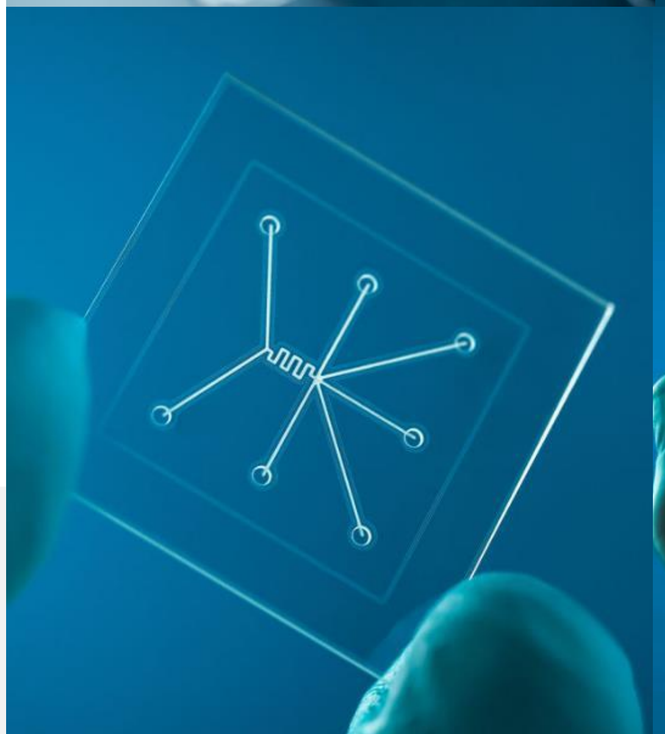
## Patent family of 13 in-house and 2 licensed patents

## 50+ professionals

7 Ph.D., 45 M.S. and B.S.

## R&D studies

continuous projects with academic and research partners



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LITHUANIAN LASER ASSOCIATION

Toolas

ISO certified

SERTIKA ISO 9001

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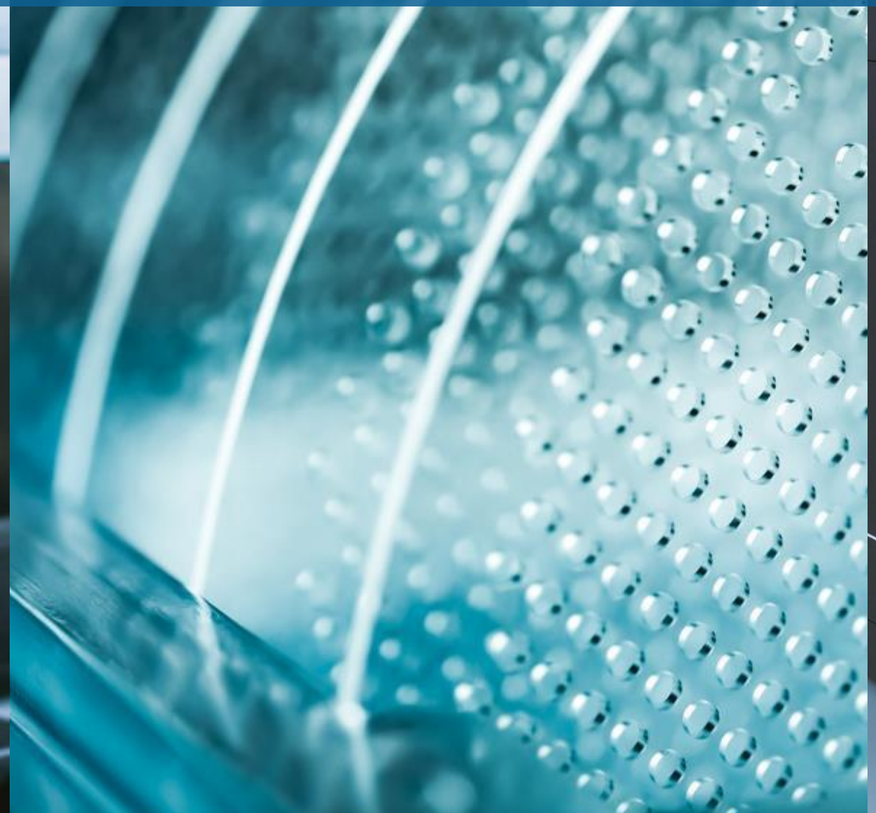
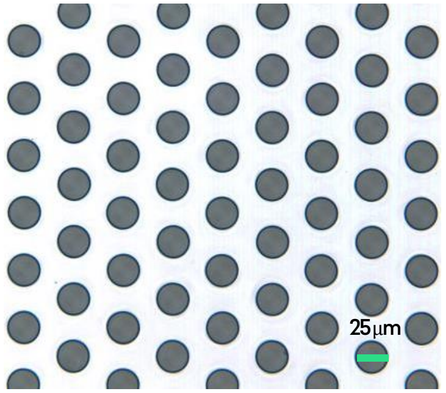
## Solution development | R&D

## Contract manufacturing

## Hardware | laser systems



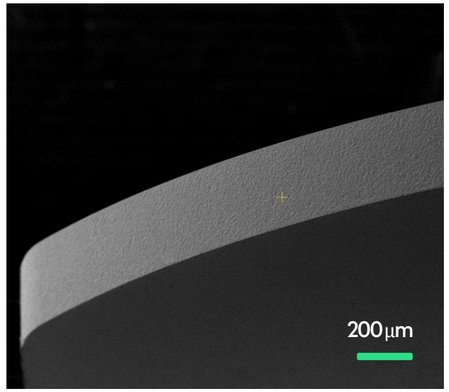
# WOP Laser Applications




## LASER MICRO DRILLING

Glass, Sapphire, Silicon, Ceramics,
Optical Fibers, Metal, Plastic

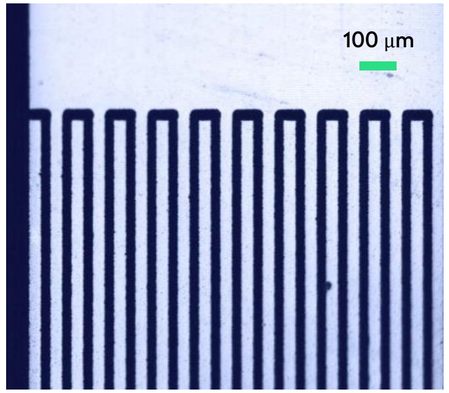
*Picture: glass wafer drilling*




## LASER MICRO CUTTING

Glass, Thin Films, Foil, Sapphire, Polymers

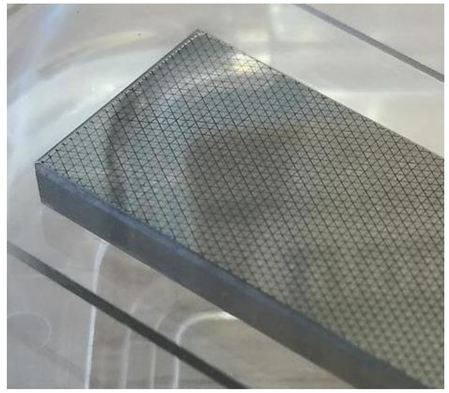
*Picture: D263T glass cutting, thickn. 300 µm*




## SURFACE STRUCTURING

Selective laser ablation
Functional surface modification
Fiber tip processing

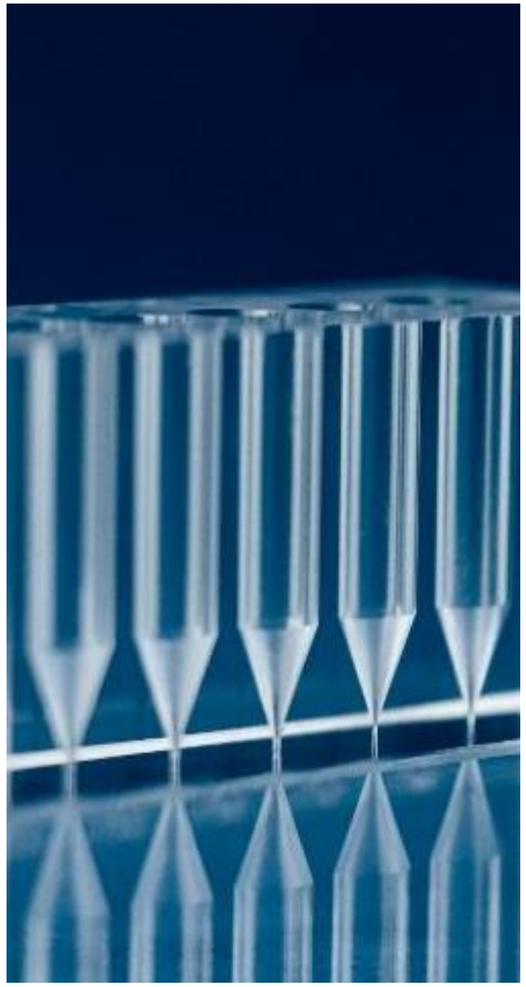
*Picture: chrome ablation from glass substrate*



## LASER WELDING

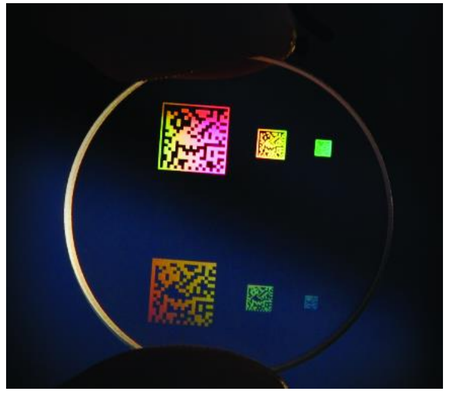
Transparent materials with transparent
and non-transparent materials

*Picture: glass to metal welding*



## SELECTIVE LASER ETCHING | SLE

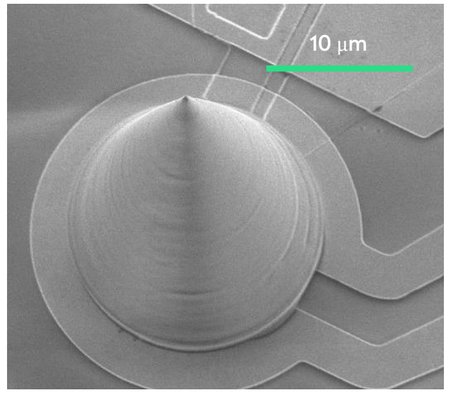
Picture: fiber alignment arrays, with SLE



## LASER MICRO MARKING

Inside transparent materials
On the surface of various materials

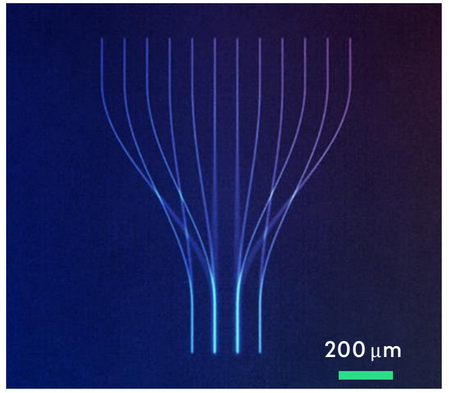
*Picture: written directly inside the object by making refractive index irregularities without damaging the surface.*




## MULTIPHOTON POLYMERIZATION

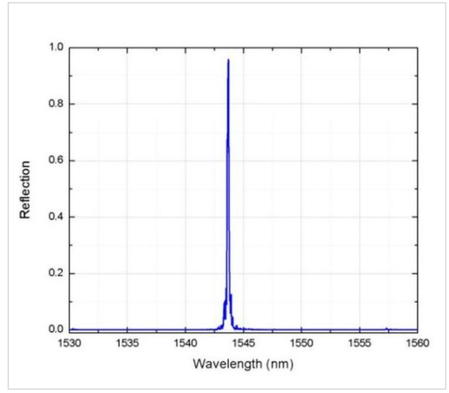
MPP, 2PP

*Picture: functional structures nano printing on existing functional devices*




## WAVEGUIDE WRITING

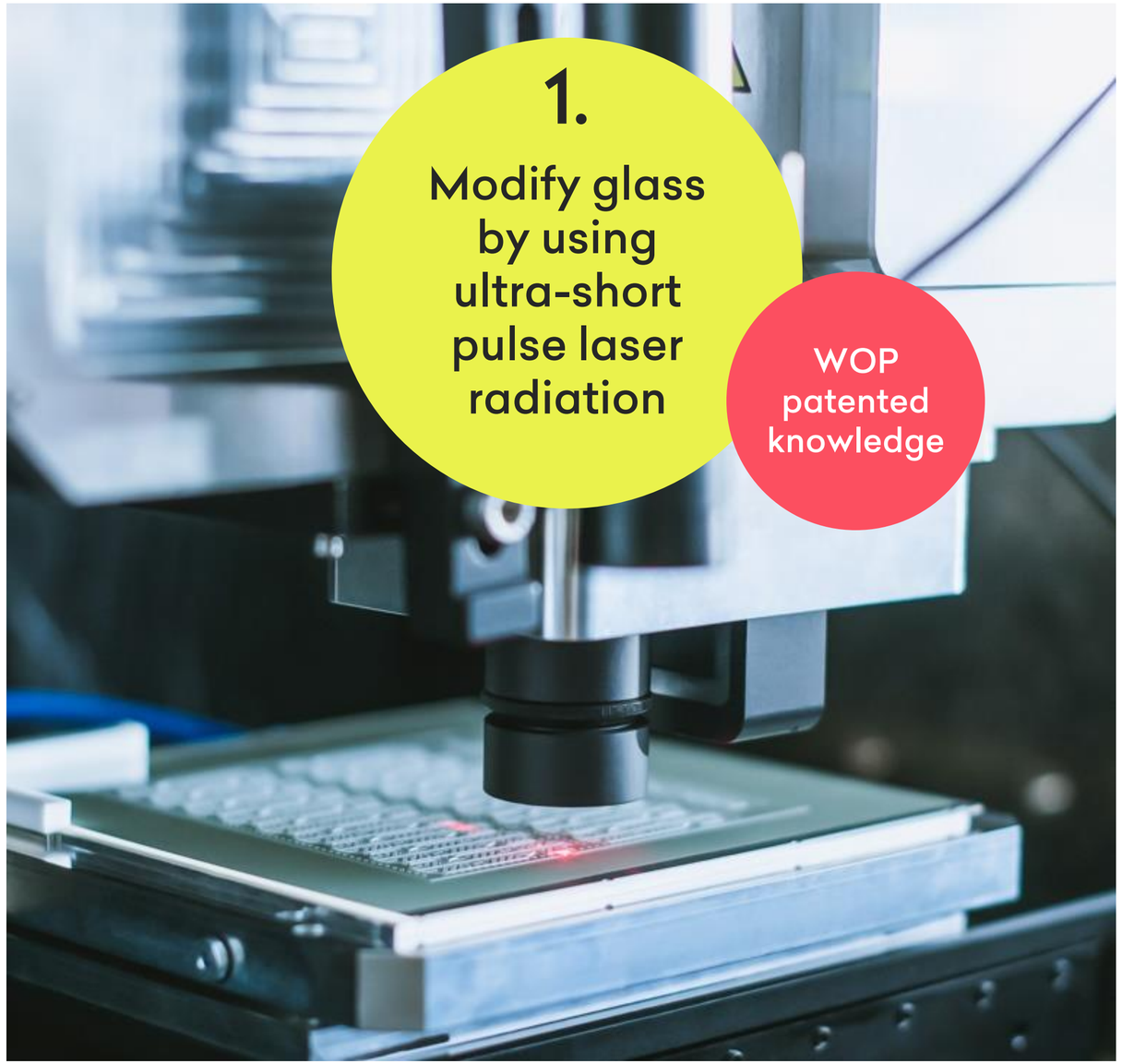
2D & 3D waveguide writing




## FBG WRITING

High reflectivity and transmission FBG's

# SLE is a two-step process:




# SLE Allows to Reach Exceptional Properties

**SLE technology ensures**
zero micro-cracks or chipping

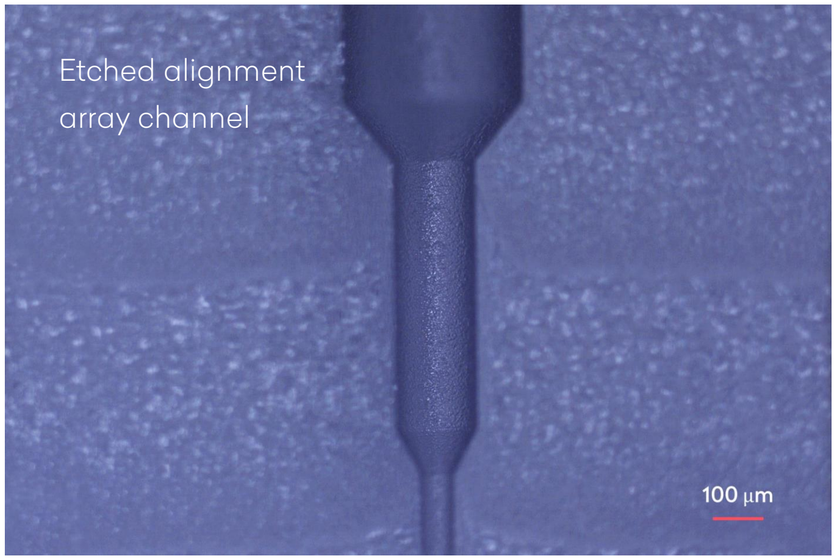
**Various shapes:**
circular, square, irregular

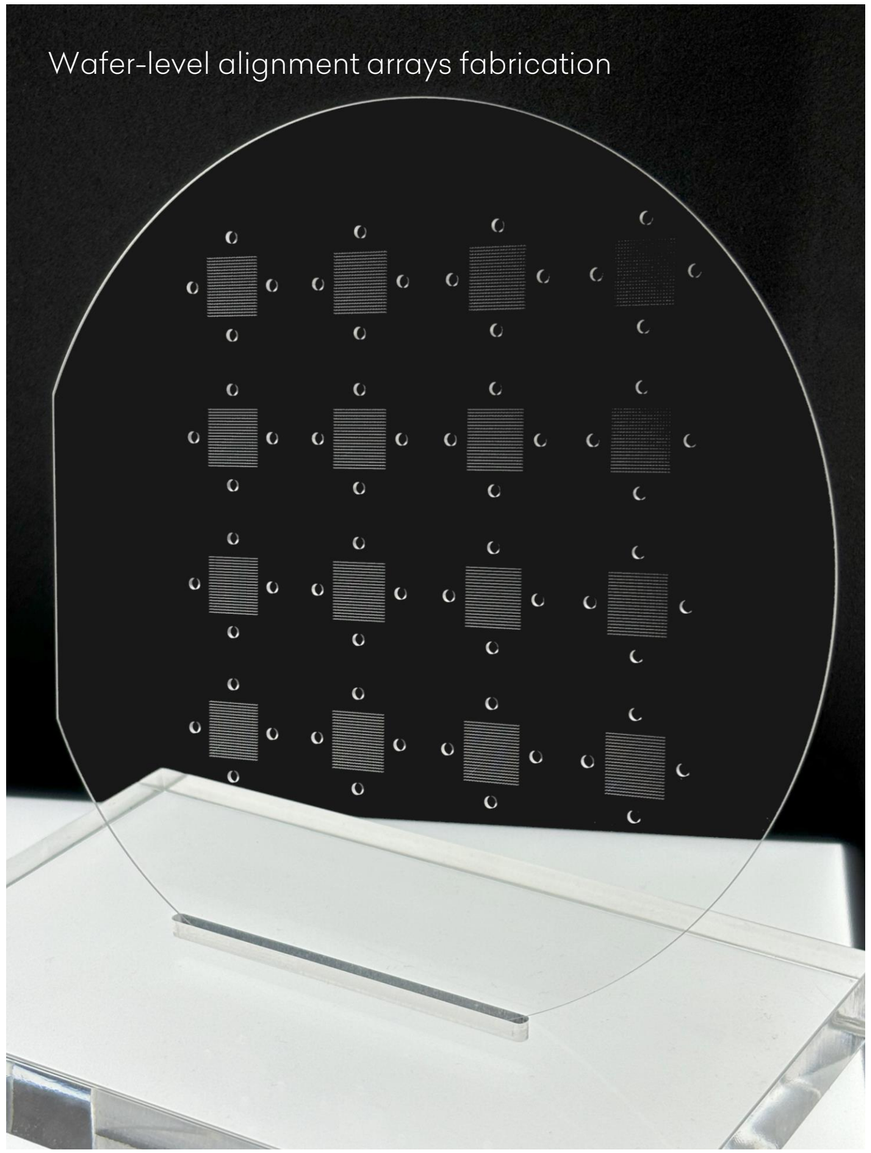
**High aspect ratio**
up to 1:100

**Glass types:**
Borofloat 33 and Fused Silica

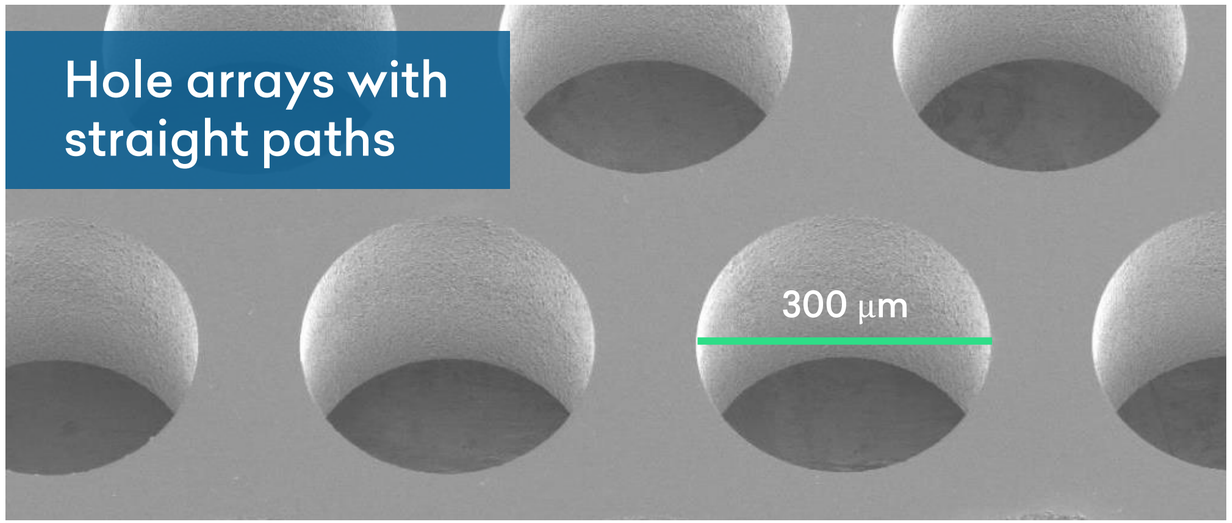
**Wafer level production**
up to 200 mm x 200 mm (8”)

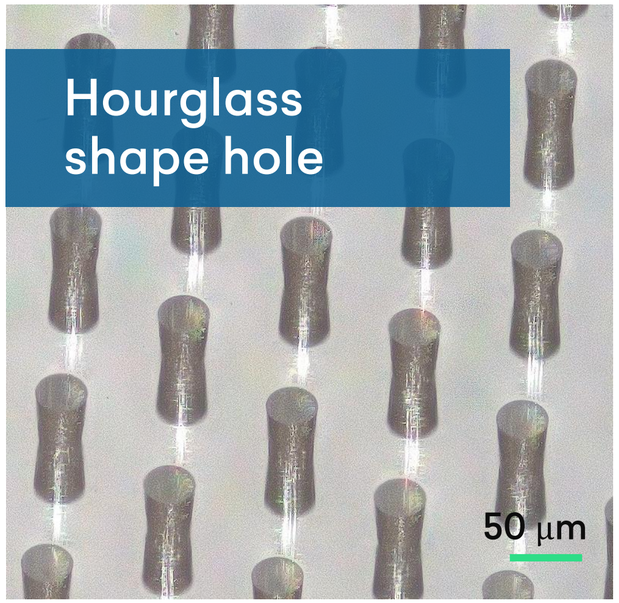
**Thickness:**
from 500 μm to 6 mm

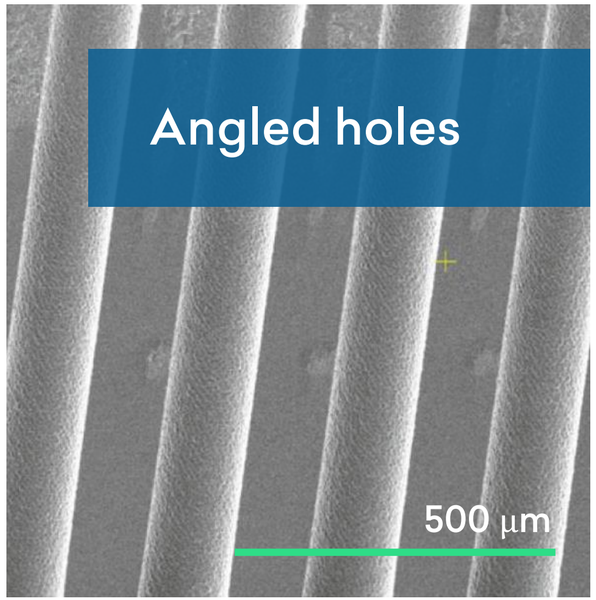



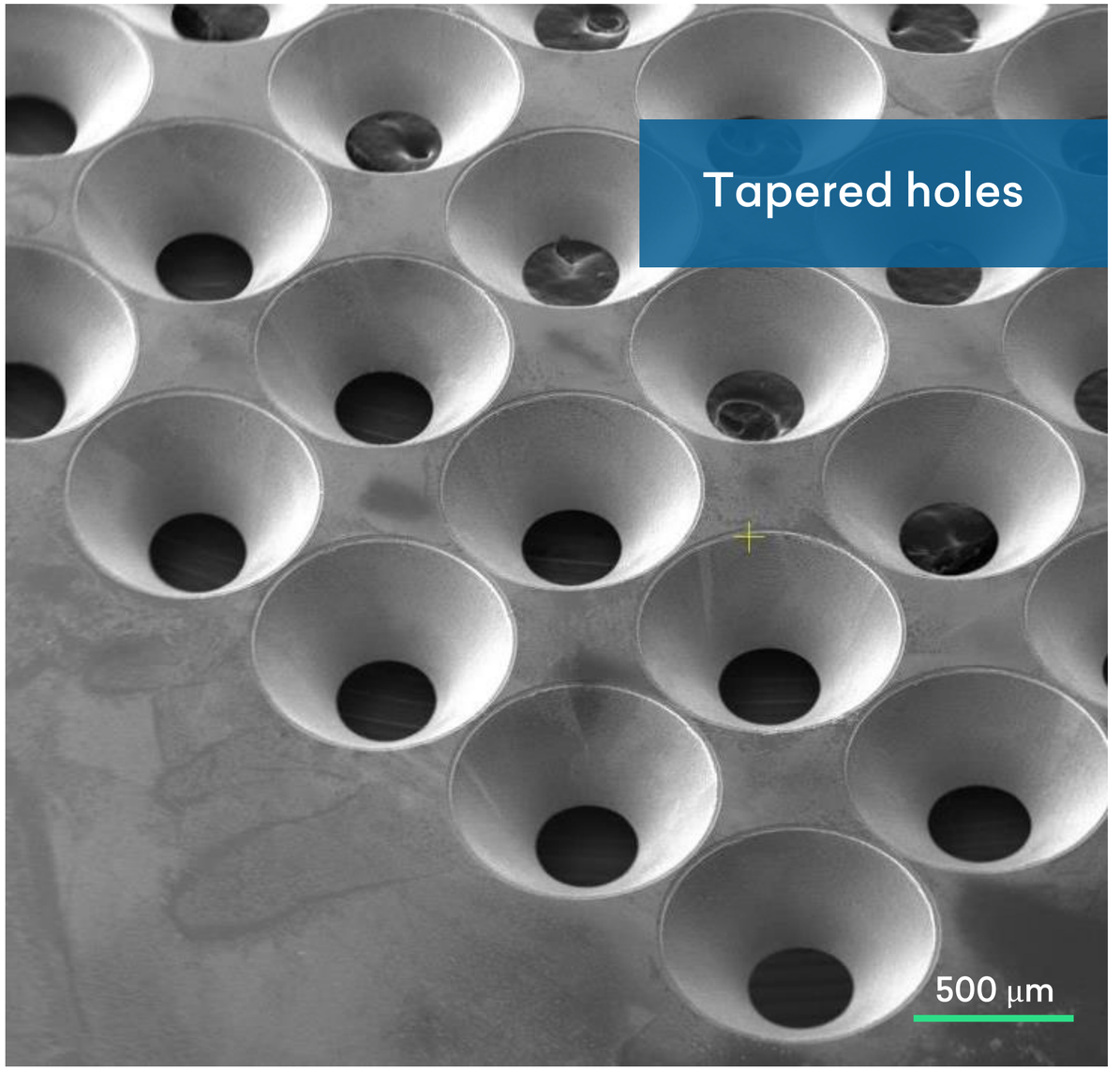



# All Kind of Holes in Glass



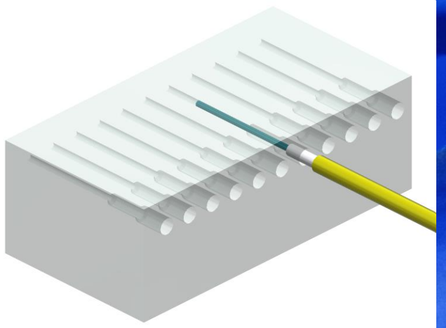



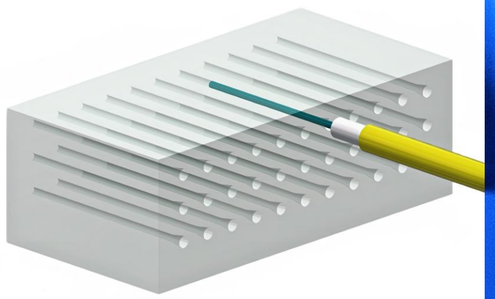



# SLE | Perfect Technology For Enhanced 2D Optical Fiber Alignment

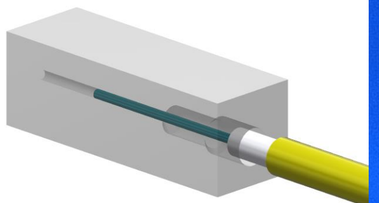
- Designed for:
  - standard SMF fibers, diameter 125/250 µm,
  - reduced clad fibers 80 µm (not limited)
- Tight tolerances within ±0.25 µm
- High density, standard 0,25 mm pitch
- Circularity < 1 µm diameter
- Diameter tolerance ± 0,5 µm
- Pitch tolerance ± 0,5 µm
- Positional accuracy < 0,5 µm
- Straight, flared, or with a cone for easier insertion
- Straight or angled holes



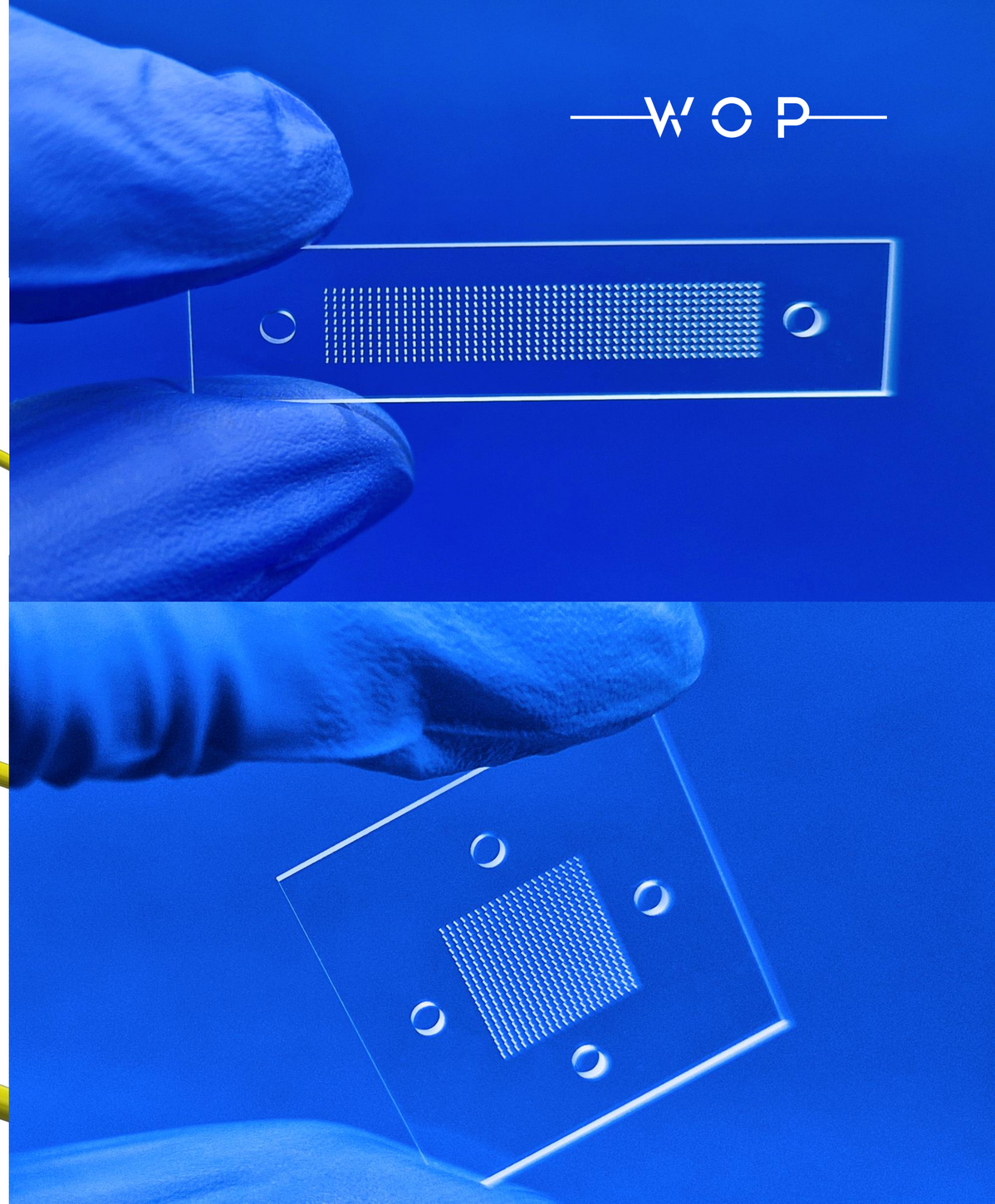
1D Alignment array with SMF fiber



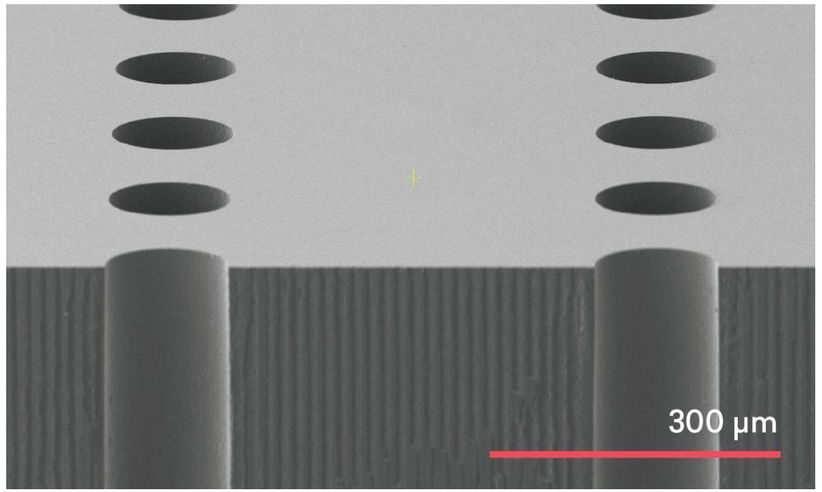
2D Alignment array with SMF fiber

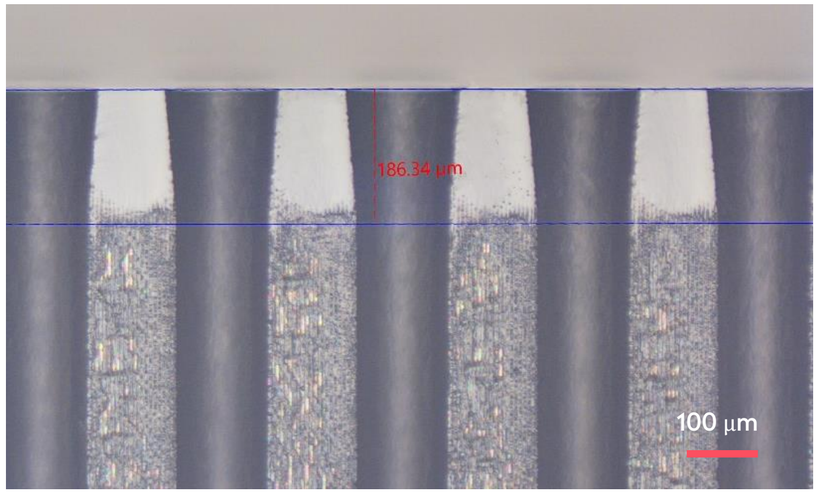


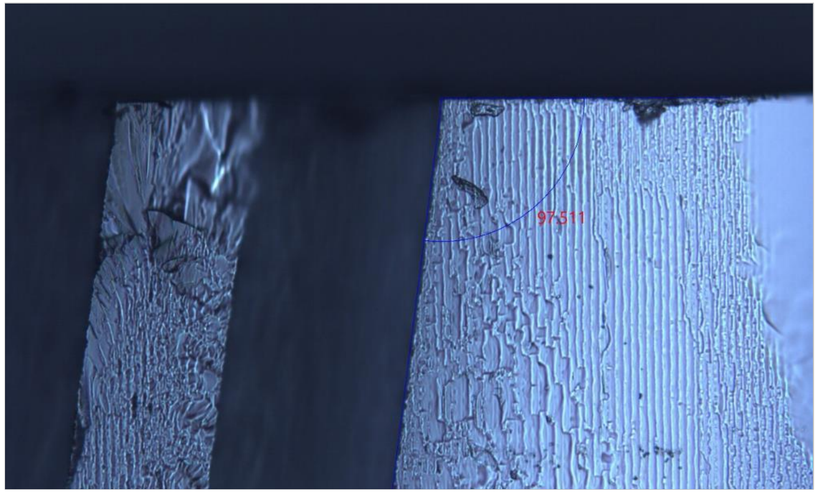
One hole example with SMF fiber

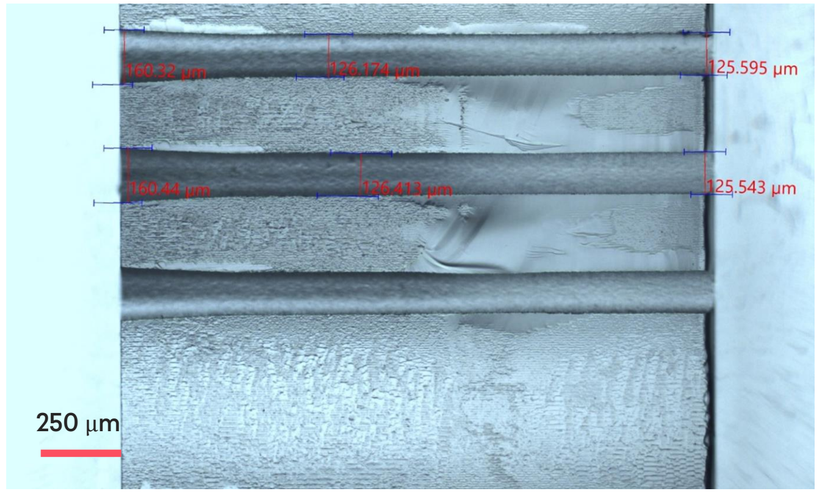


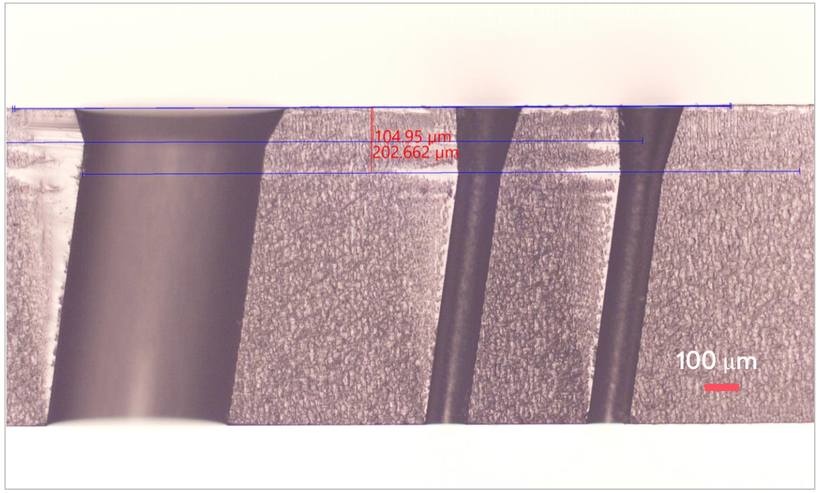
# All Guide Shapes



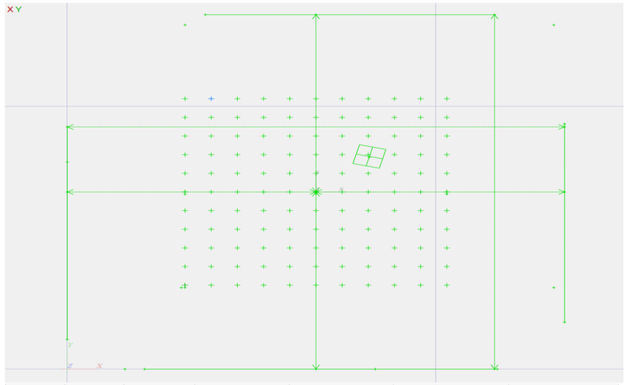



# Sub-micron control of 2D Optical Fiber Alignment

**2D array 11x11 (Hole diameter = 125.5 ±0.5 µm)**

## FIBER CORE/HOLE POSITION ERROR

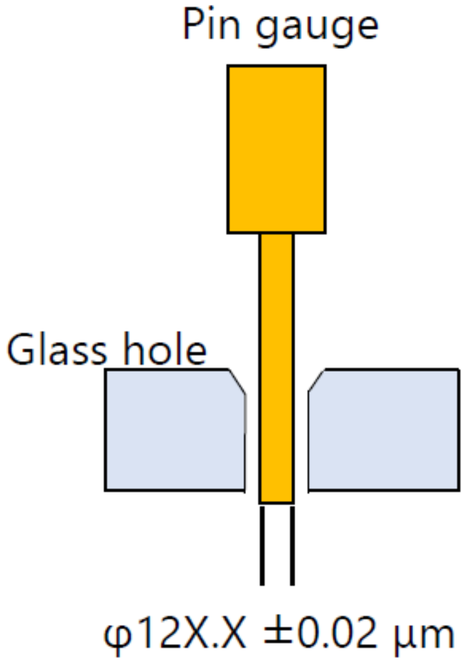
**Automated measurement tool Nikon Nexiv VMZ-S for X,Y, D, TRUE POSITION**



| Hole Nr. | | Nom., µm | UpperTol., µm | LowerTol., µm | Sample Nr. 1 Measured, µm | Sample Nr. 5 Measured, µm |
|---|---|---|---|---|---|---|
| 1-1 | X | 0 | 0,5 | -0,5 | -0.0 | 0.0 |
| 1-1 | Y | 0 | 0,5 | -0,5 | -0.0 | -0.0 |
| 1-1 | D | 125,5 | 0,5 | -0,5 | 125.8 | 125.9 |
| 1-8 | X | 1750 | 0,5 | -0,5 | 1750.0 | 1750.0 |
| 1-8 | Y | 0 | 0,5 | -0,5 | -0.3 | -0.2 |
| 1-8 | D | 125,5 | 0,5 | -0,5 | 125.9 | 126.1 |
| 1-16 | X | 3750 | 0,5 | -0,5 | 3749.8 | 3749.9 |
| 1-16 | Y | 0 | 0,5 | -0,5 | -0.4 | -0.1 |
| 1-16 | D | 125,5 | 0,5 | -0,5 | 125.8 | 126.0 |
| 1-24 | X | 5750 | 0,5 | -0,5 | 5749.6 | 5750.1 |
| 1-24 | Y | 0 | 0,5 | -0,5 | -0.4 | -0.0 |
| 1-24 | D | 125,5 | 0,5 | -0,5 | 126.0 | 126.1 |
| 1-32 | X | 7750 | 0,5 | -0,5 | 7749,6 | 7749.9 |
| 1-32 | Y | 0 | 0,5 | -0,5 | 0.0 | -0.0 |
| 1-32 | D | 125,5 | 0,5 | -0,5 | 125.9 | 126.0 |
| 8-1 | X | 0 | 0,5 | -0,5 | -0,4 | 0.1 |
| 8-1 | Y | -1750 | 0,5 | -0,5 | -1749.9 | -1750.0 |
| 8-1 | D | 125,5 | 0,5 | -0,5 | 125.8 | 125.9 |
| 8-8 | X | 1750 | 0,5 | -0,5 | 1749,6 | 1749.8 |
| 8-8 | Y | -1750 | 0,5 | -0,5 | -1749.8 | -1750.2 |
| 8-8 | D | 125,5 | 0,5 | -0,5 | 125.8 | 125.7 |

## HOLE DIAMETER CONTROL

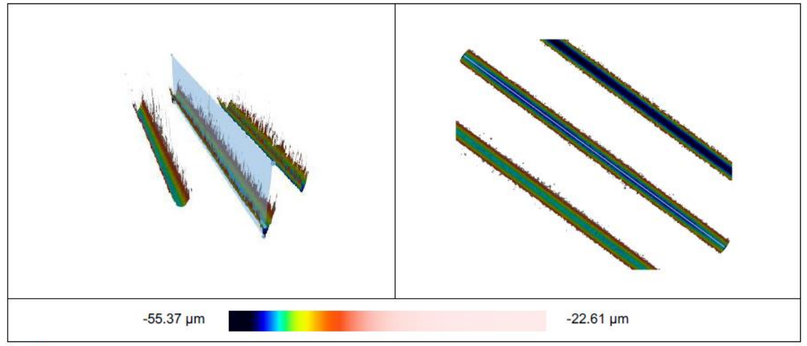
**Guiding section verification by using mechanical pins and fibers itself**



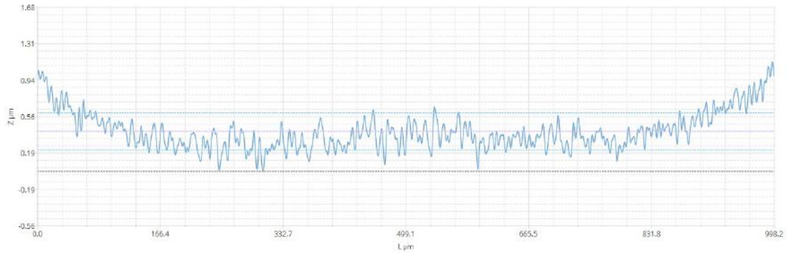

## ROUGHNESS INSIDE THE HOLE

**3D Optical Profiler Sensofar Neox**

**Visualization**

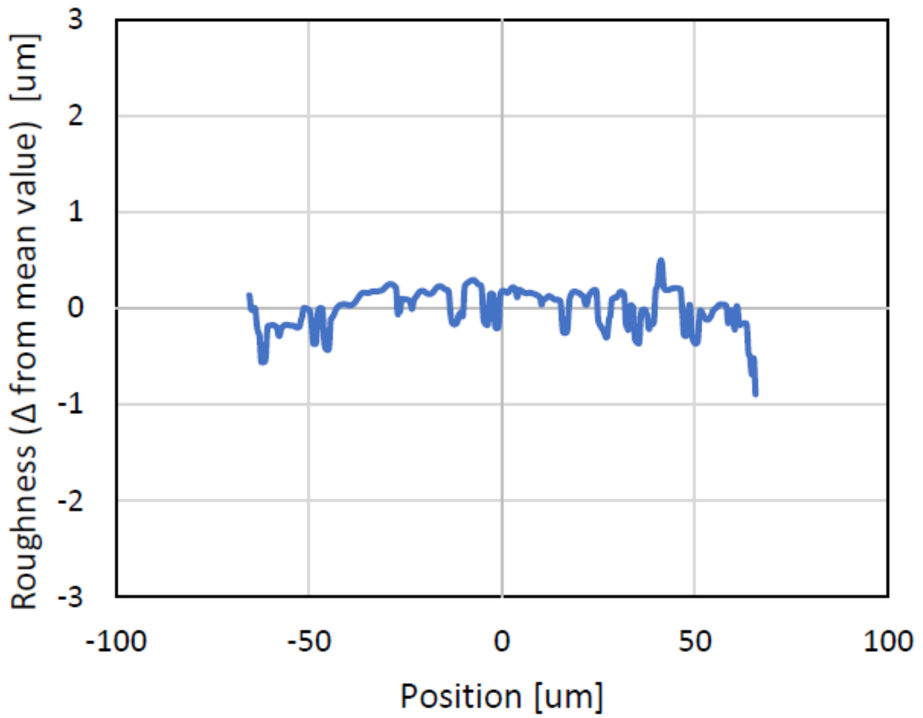


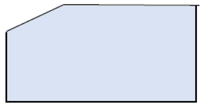

**Profile**




**High-end metrology:** Scanning electron microscope | SEM, Sensofar Neox profilometer, Nikon Nexiv VMZ-S

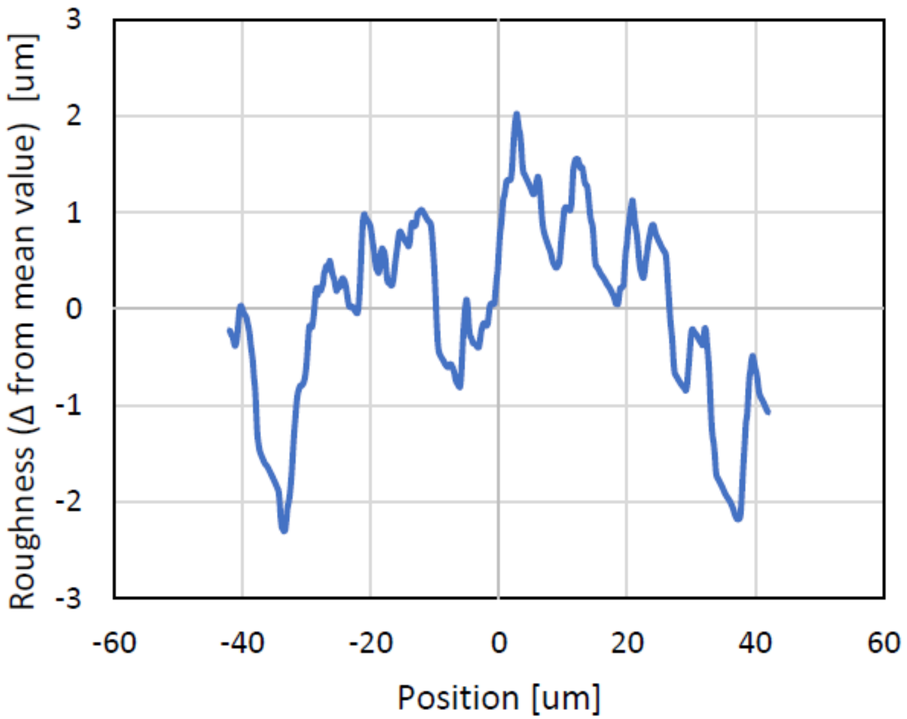
# Evaluation 1: Hole Roughness

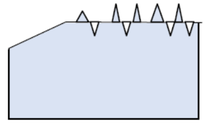


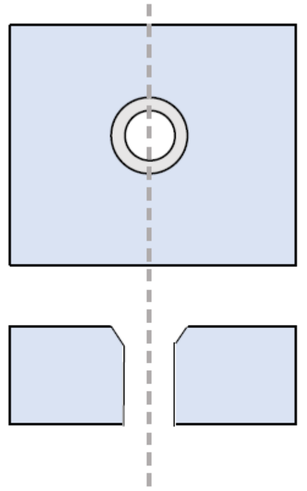
Very smooth & Small deviation
→ Good hole for fiber aligner

Other glass hole array



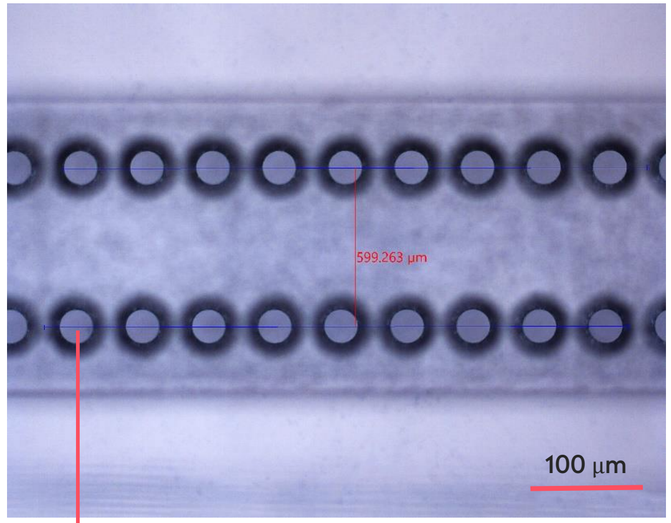



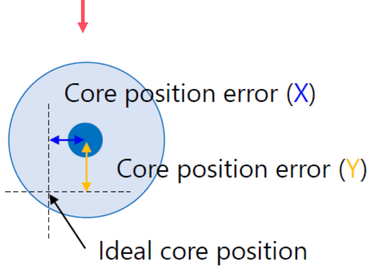
Very rough
→ Not good



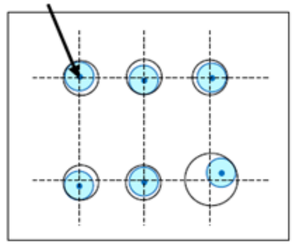
Cut the glass hole array and measured roughness of inside hole.

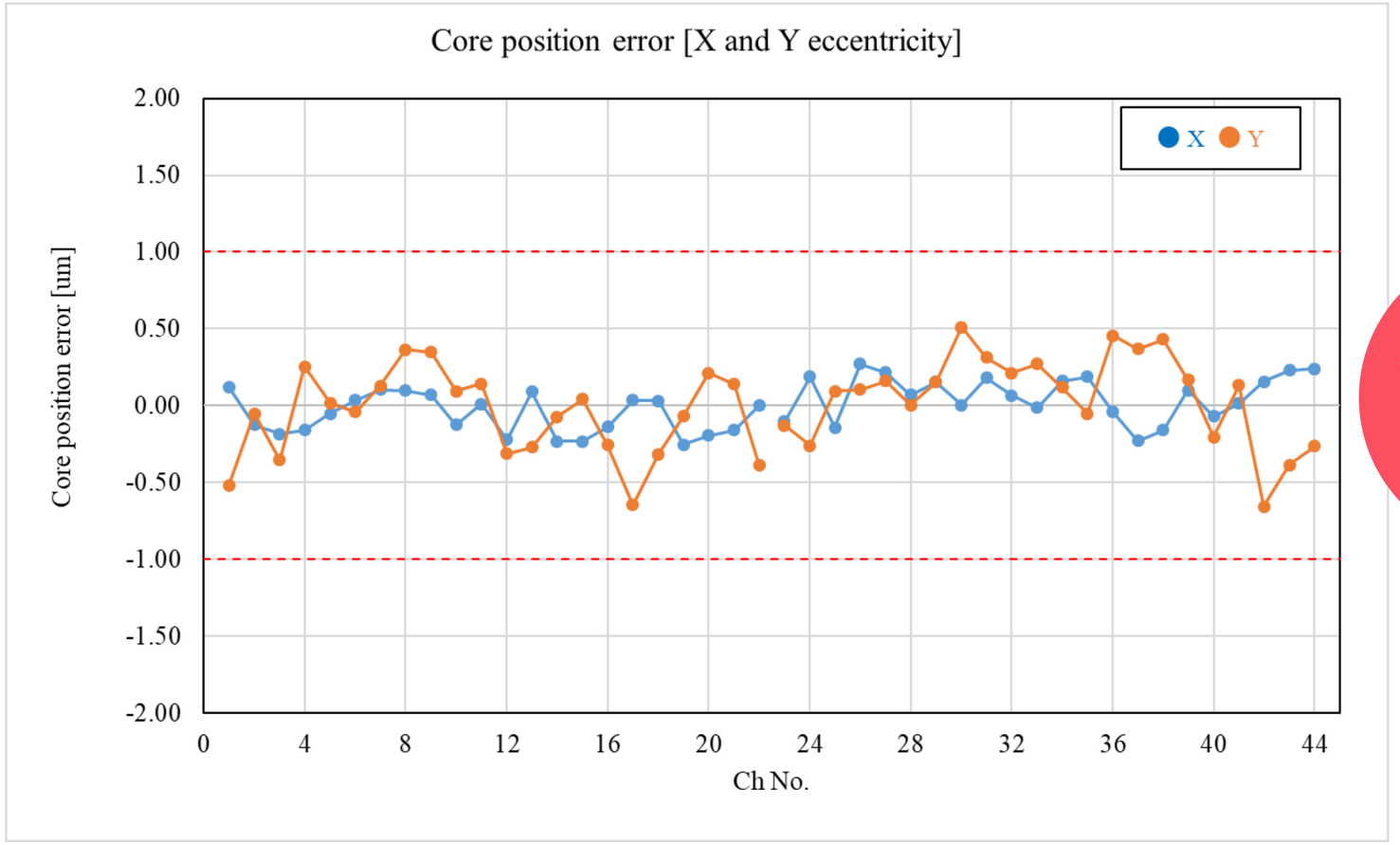
# Evaluation 2: Fiber Core Position




Ideal position

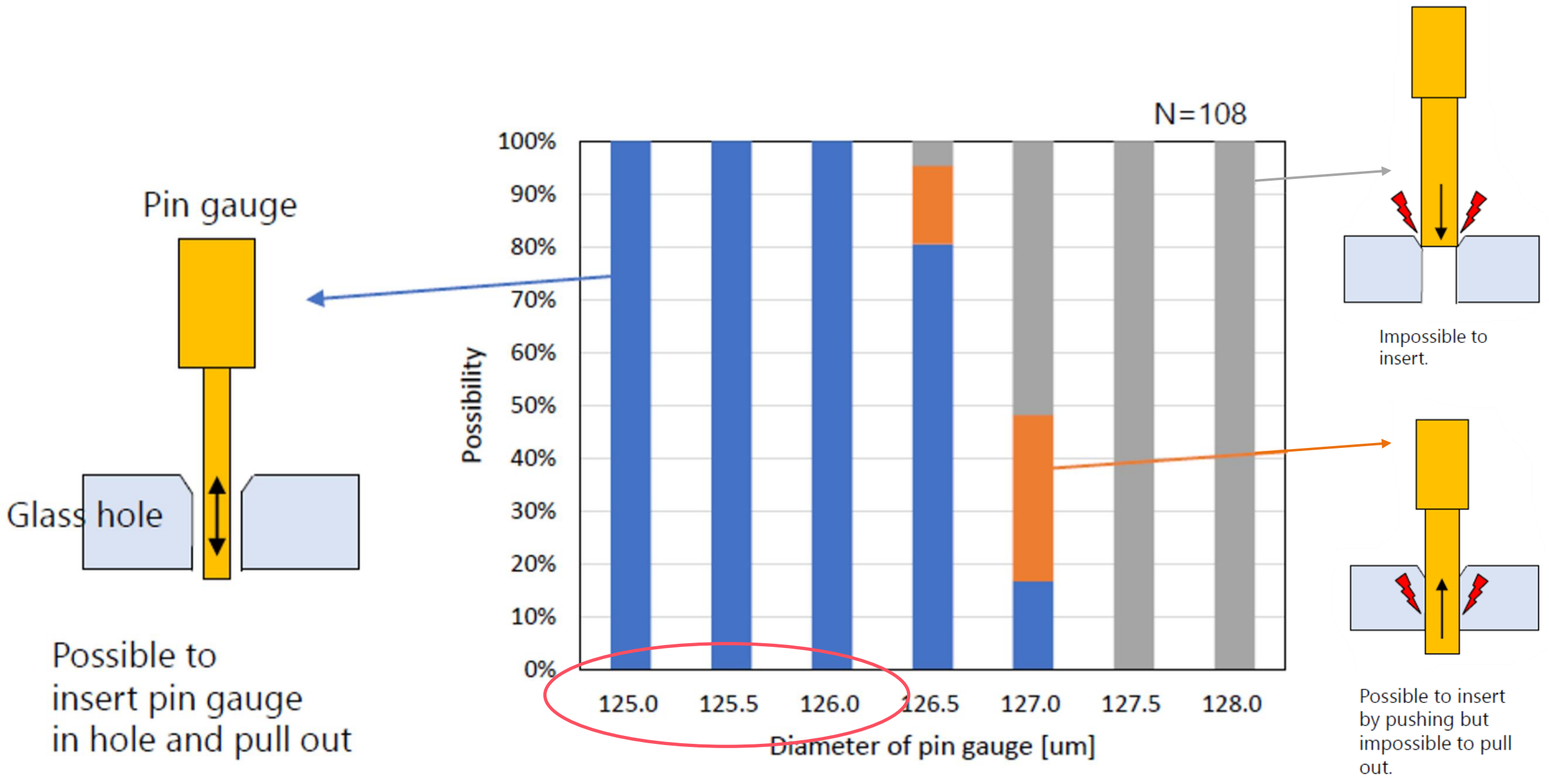


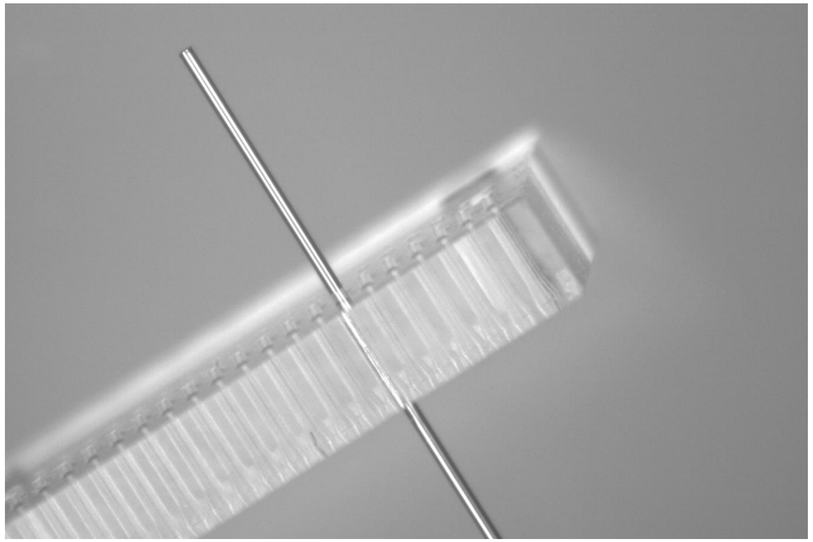



Average core positioning error ±0.5 µm

Low core position error is confirmed.
Low coupling loss is expected.

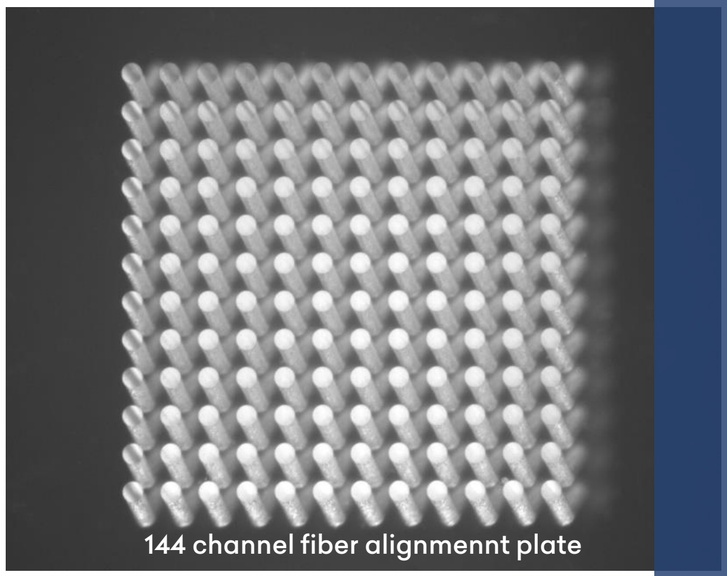
# Evaluation 3: Perfect Hole Diameter

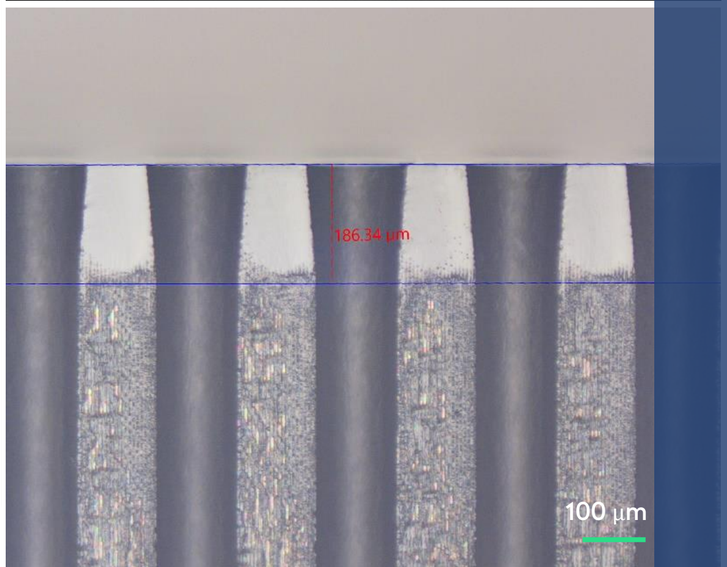


**Specification of hole diameter is 126 +1/ -0 µm**

# Perfect Fiber Arrays



144 channel fiber alignmennt plate




- **High density |** standard 0,25 mm pitch
- **High core position accuracy |**
  Average core positioning error ±0.5 µm
- **Tight tolerances** within ±0.25 µm
- **Heat resistance**
- **CTE matching to Silicon**
- **Low coupling losses**
- **Ultrafast direct laser writing |**
  suitable for high-scale production

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# Thank you & let's connect!

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