

FEMTOprint

3D printing for glass microdevices



SWISS PHOTONICS

3D Microfabrication Platform:
New Achievements in Industrial Applications

Nicoletta Casanova
13.06.2018 – EPHJ/EPMT/SMT – Swiss Photonics - Geneva, Switzerland

FEMTOprint

FEMTOprint SA, founded in December 2013, is a Swiss high-tech company manufacturing **3D printed micro-devices out of glass** and other transparent materials. It equally develops and assembles **its own 3D printing platforms** for rapid prototyping and serial production. Its versatility, adapted for multiple industries, and the inexpensive configuration (i.e. no need of a cleanroom and masks) makes it an affordable and transformative solution to leading-edge markets.

Through the innovative FEMTOPRINT® technology and the highly-qualified expertise in micromachining, FEMTOprint is **changing the way industrial, highly complex micro-systems are conceived, enhancing the innovation.**




AN EYE BEHIND



Company based in Lugano with exclusive IP rights



18+ employees




ISO 13485:2016 certified



2010 – 2013
European project,
investment EUR 3.39M



In operation since
February 2014



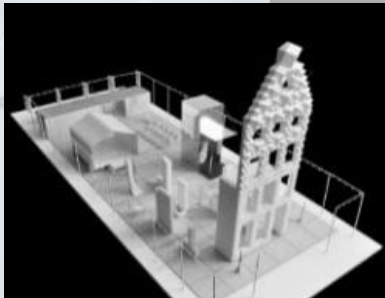
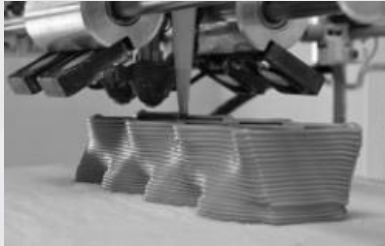
Production series > 1'000
Contracts 100K SKU's / year





THE 3D PRINTING WORLD

3D PRINTING



Additive
manufacturing

Subtractive
manufacturing



3D PRINTING



FEMTOprint

Pillar $\phi 20\ \mu\text{m}$



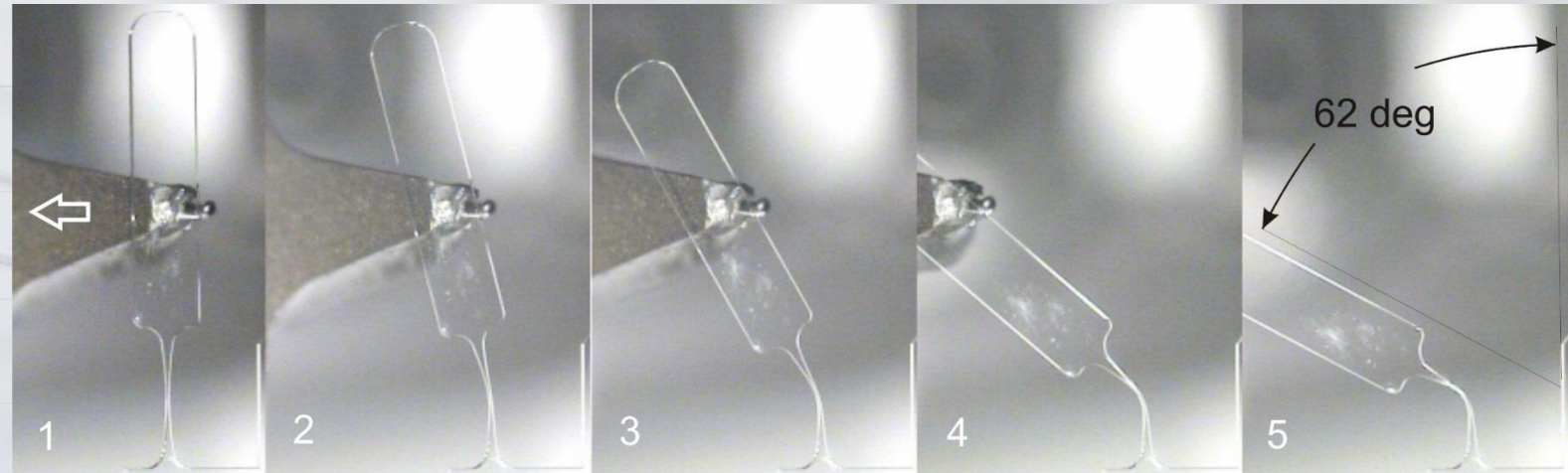
Subtractive
manufacturing



WHY NOT GLASS?

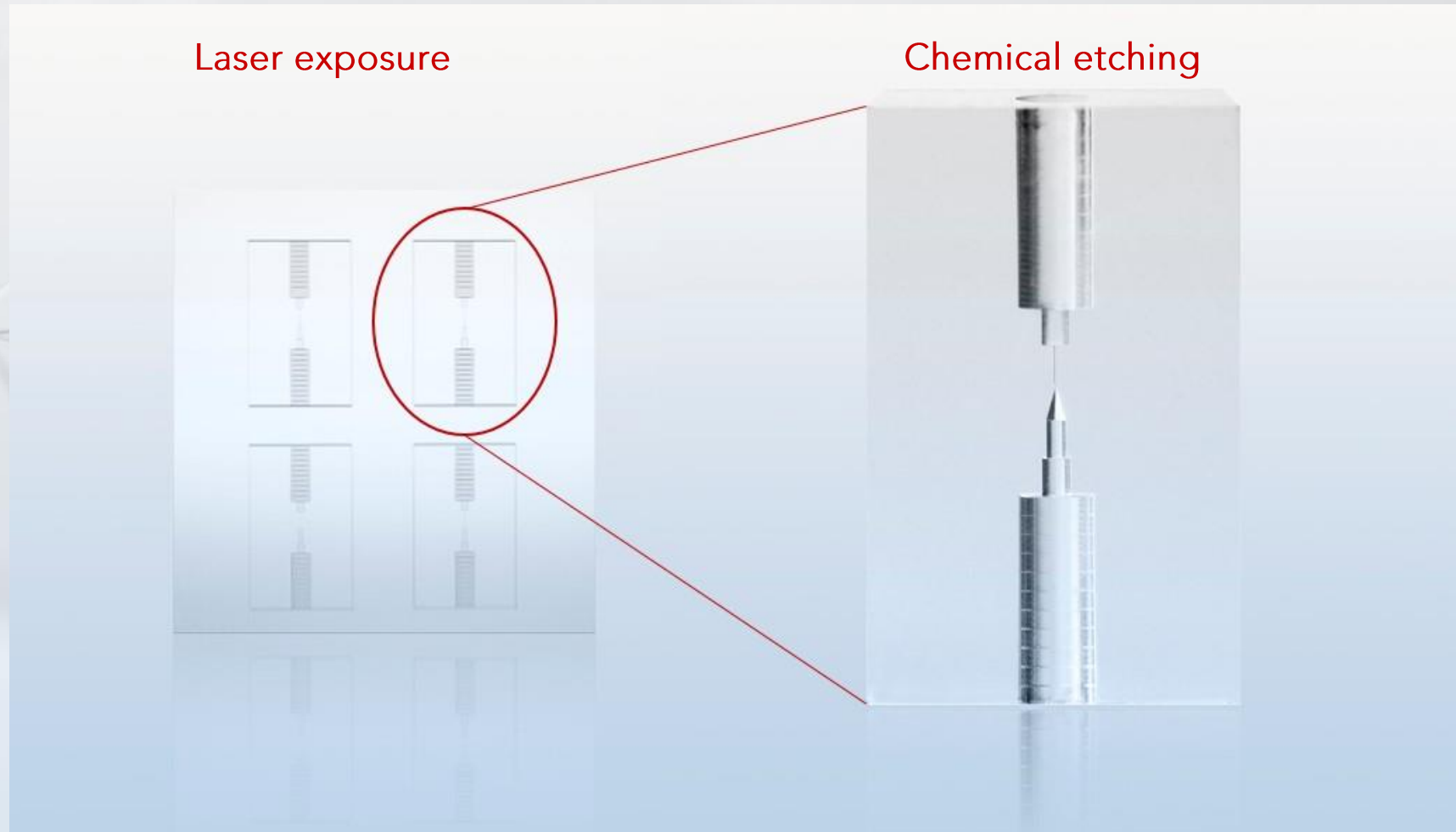
Main benefits

- 01 TRANSPARENT AND ISOTROPIC
- 02 STABLE AND ELECTRICALLY INSULATING
- 03 BIOCOMPATIBLE
- 04 ELEVATED THERMAL PROPERTIES
- 05 ELASTIC
- 06 RESISTANT TO CORROSION, ABRASION AND SCRATCHES



FEMTOPRINT® TECHNOLOGY

Selective subtracting manufacturing



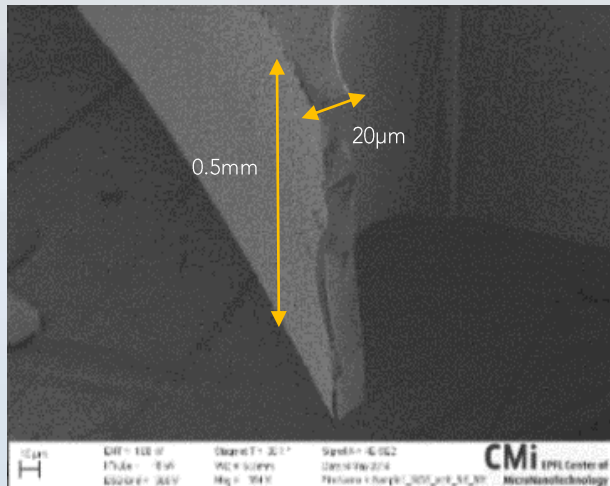
6mm

FEMTOPRINT® TECHNOLOGY

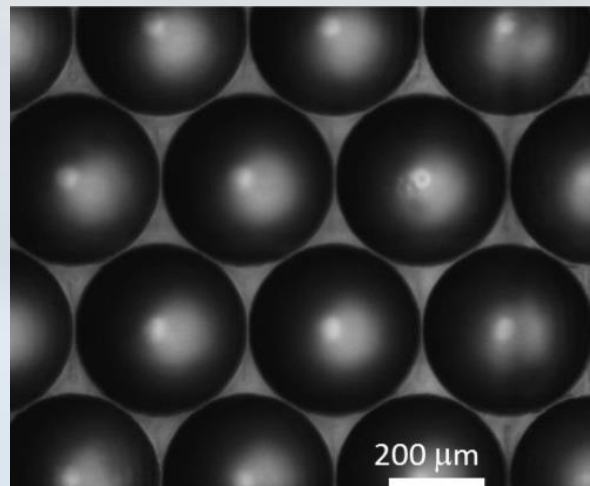
Process parameters at a glance



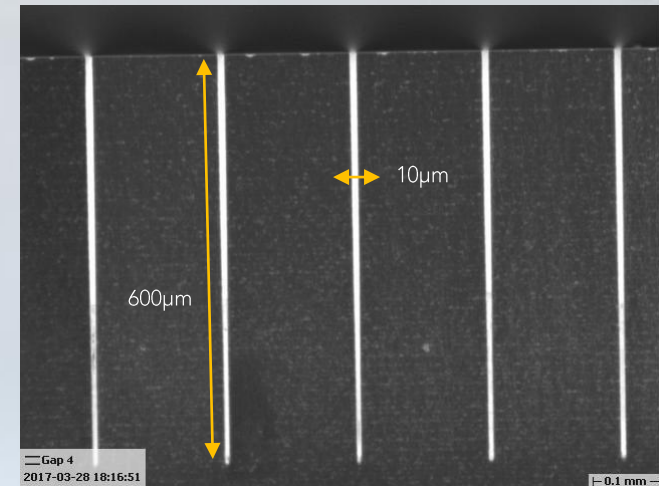
- Process resolution <math>< 1\mu\text{m}</math>
- XY tolerances $\pm 1\mu\text{m}$
- Z tolerance $\pm 2\mu\text{m}$
- Position accuracy $0.5\mu\text{m}$



- After machining $R_a \sim 80\text{nm}$
- No laser pattern visible
- After polishing $R_a < 10\text{nm}$



- Channel size: length $\gg 1:50$
- Max bulk length 10mm
- Welding for longer channels (inner pressure $> 160\text{bar}$)

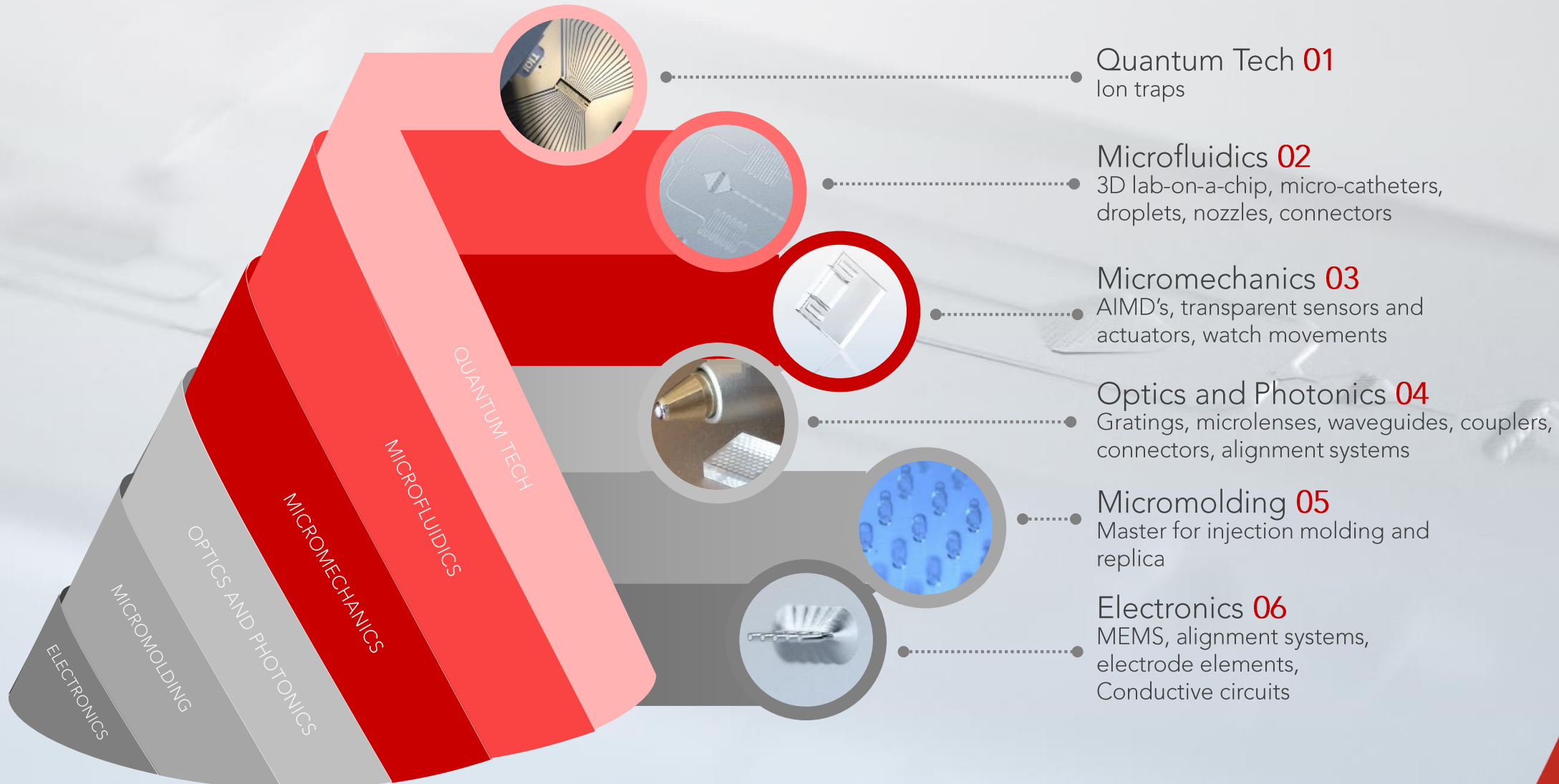




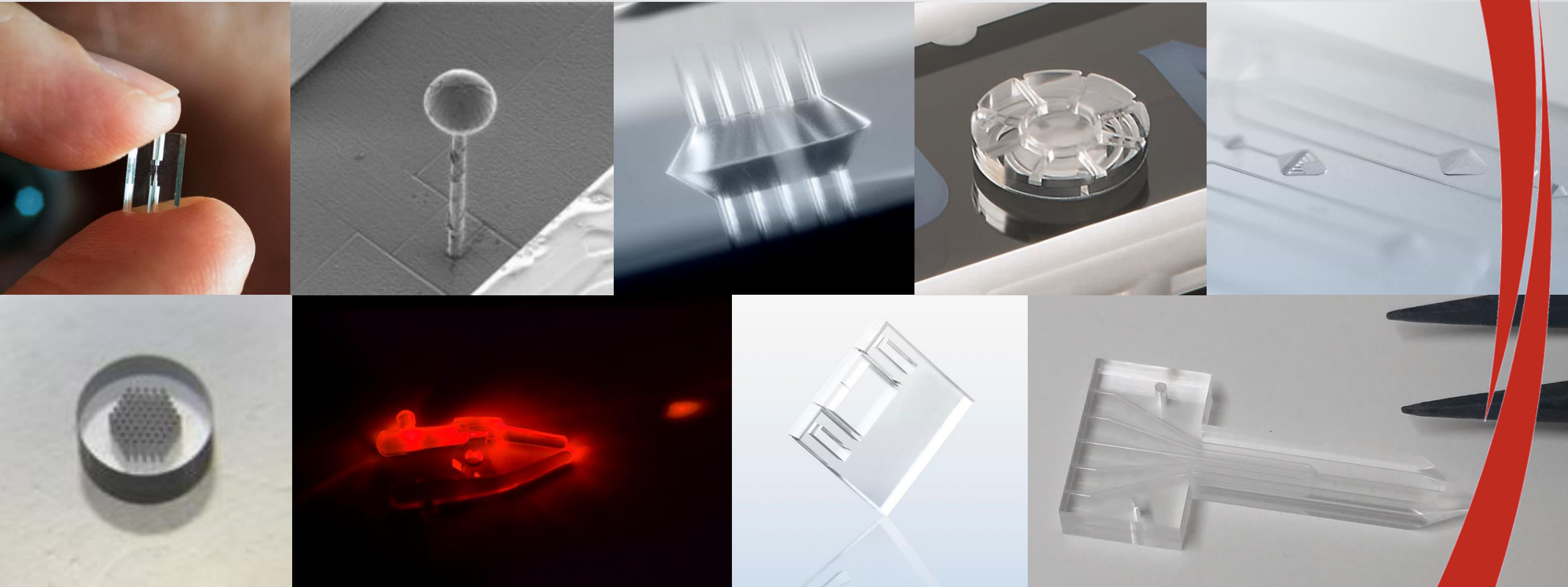
A WIDE RANGE OF APPLICATIONS

FEMTOPRINT® is a unique technology able to produce some challenging 3D structures with mass-production capabilities and without the need of a clean room, which cannot be replicated with additive nor with ablative manufacturing and would be too expensive with assembling manufacturing.

A WIDE RANGE OF APPLICATIONS

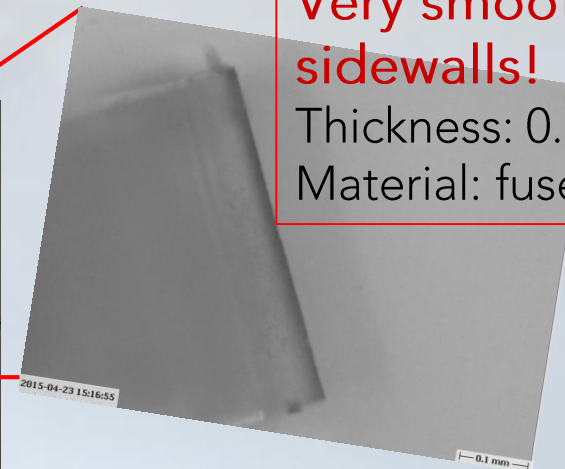
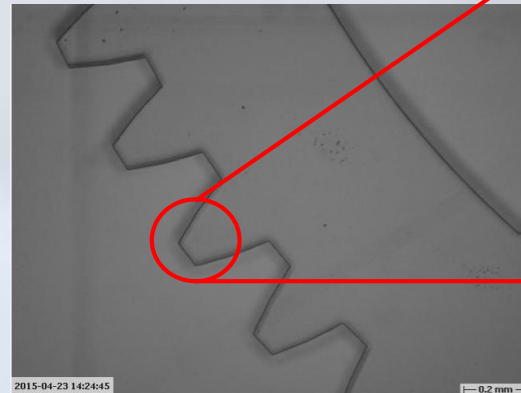
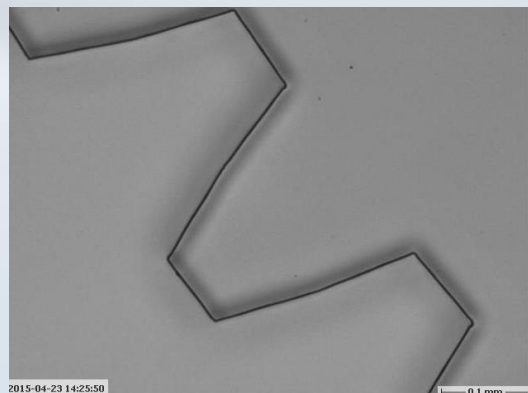


A WIDE RANGE OF APPLICATIONS



WATCHMAKERS

2.5D Micromechanics Devices
Transparent movements for watches



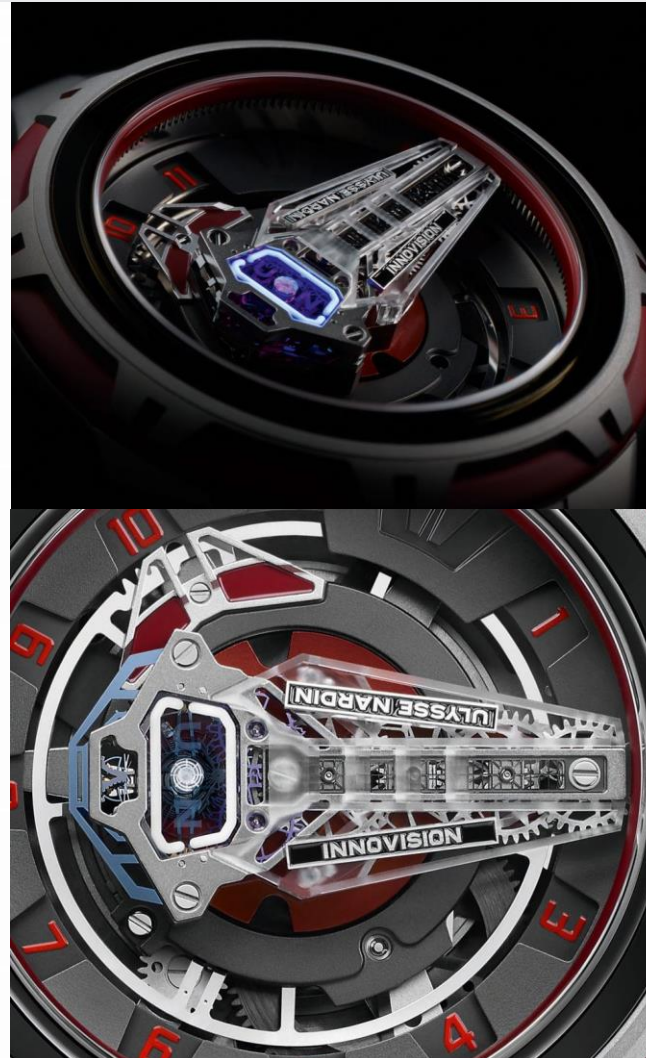
Very smooth sidewalls!
Thickness: 0.5 cm
Material: fused silica

CASE STUDY OF 3D WATCH COMPONENTS

Scope: Development of a complex 3D minute hand and a balance bridge with embedded spring and microfluidic channels.



The *InnoVision Two* concept watch



SPECIFICATIONS

Length: 18.81 mm

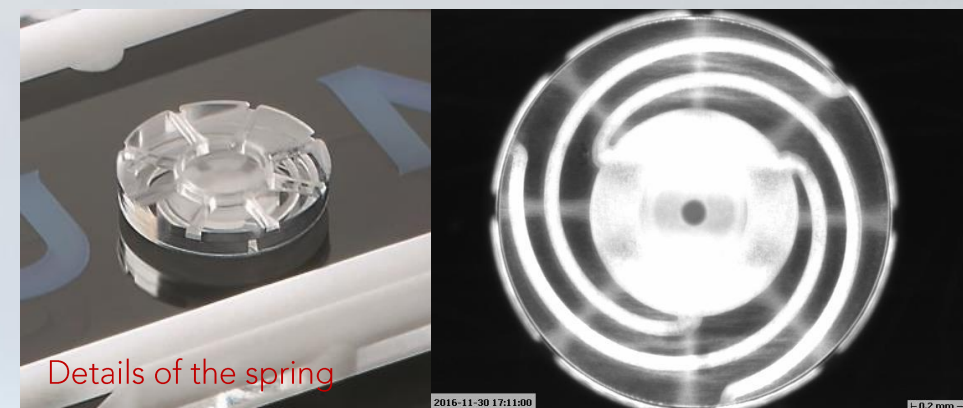
Channel diameter: 0.4 x 0.1 mm

Cavity diameter: 0.38 mm

Material: fused silica

CASE STUDY OF 3D WATCH COMPONENTS

Scope: Development of a complex 3D minute hand and a balance bridge with embedded spring and microfluidic channels.



DECORATIONS AND SECURITY

Bulk engraving of transparent materials

TEXT AND IMAGES



GRATINGS FOR COLORS



GRAY SCALE
(from transparent to white)

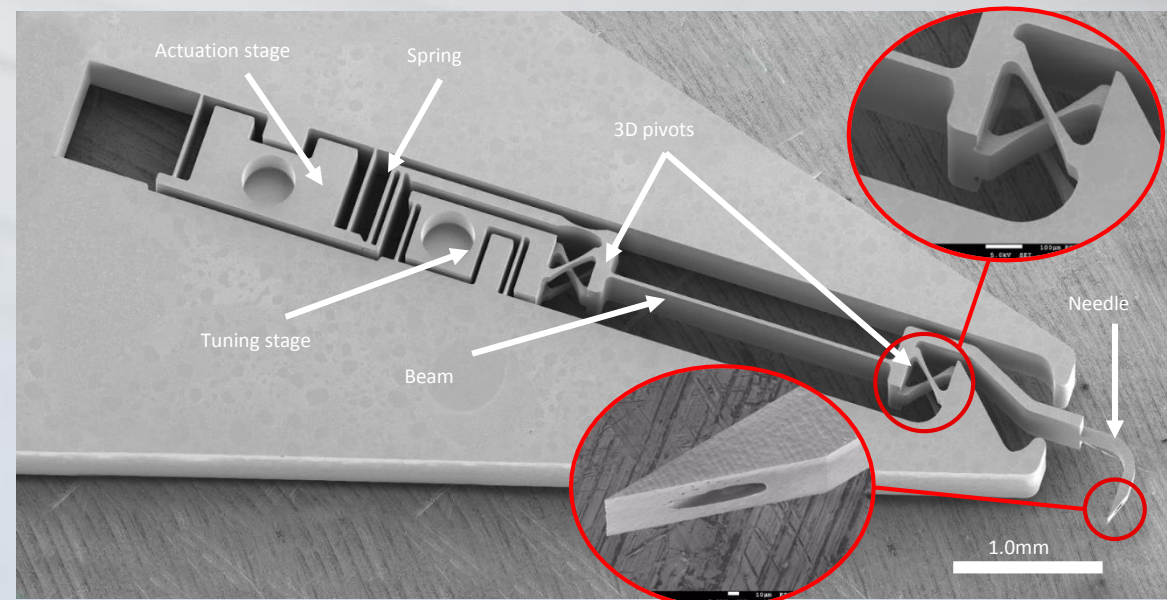


CASE STUDY OF A MEDICAL DEVICE

Scope: Development of a surgical tool out of a single piece of glass, with integrated features:

1. Micro needle for puncture into a vein
2. Fluidic channels within the needle to vehiculate drugs
3. Mechanical actuators for stroke control and optical force measurement

Application: Ophthalmology. Minimal invasive retinal vein cannulation and injection of therapeutic agents to remove the clots.

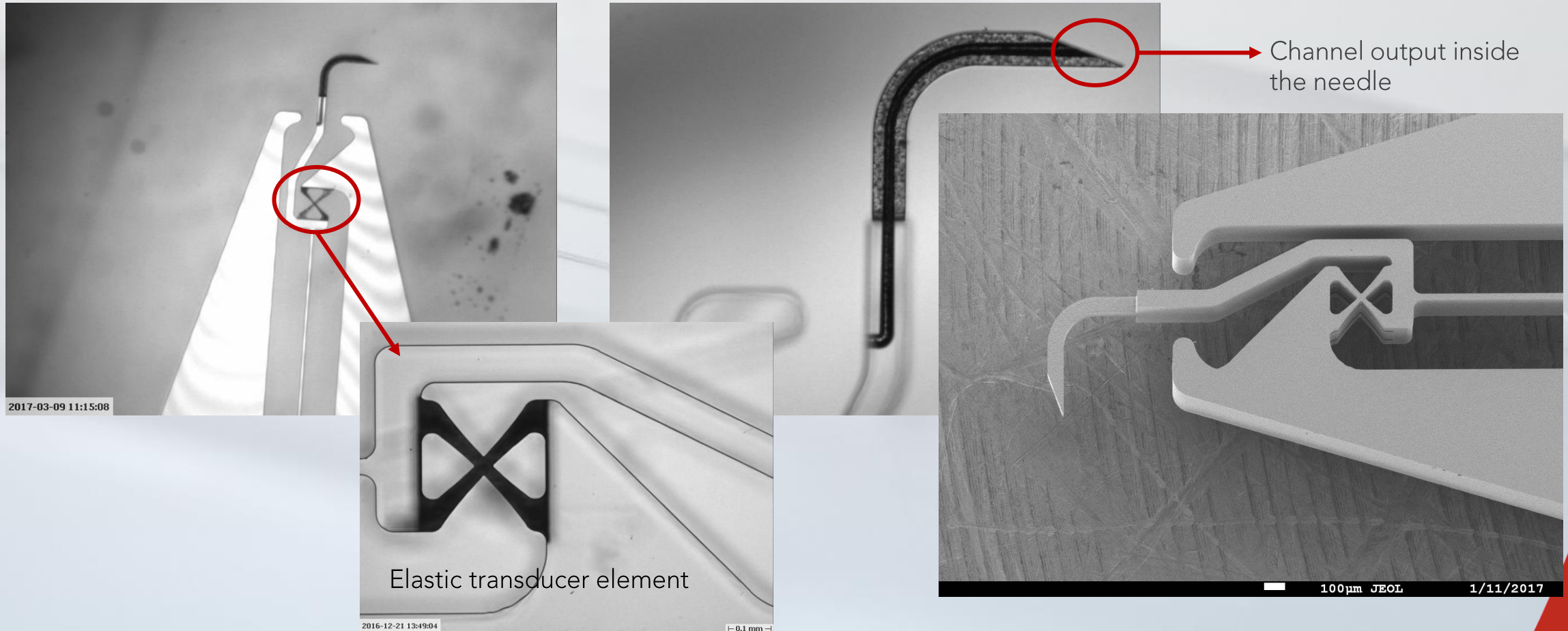


Length: 60.0mm Channel \varnothing : 70 μ m Needle \varnothing : 300 μ m

CASE STUDY OF A **MEDICAL DEVICE**

Surgical tools - Micro needle integrating fluidic channels for minimal invasive surgery

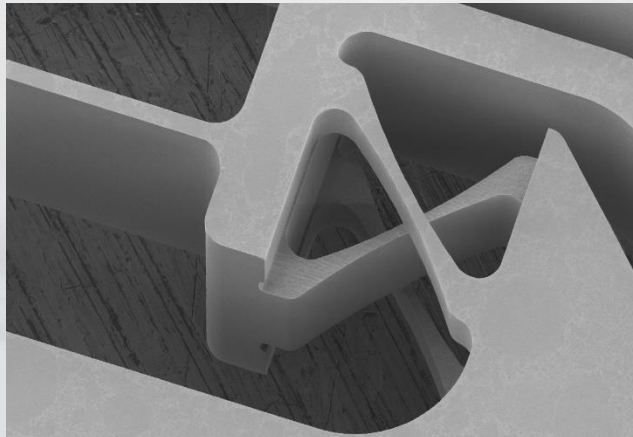
Angle deviation: 0.1° Channel \varnothing : $70\mu\text{m}$ Needle \varnothing : $300\mu\text{m}$ Material: fused silica



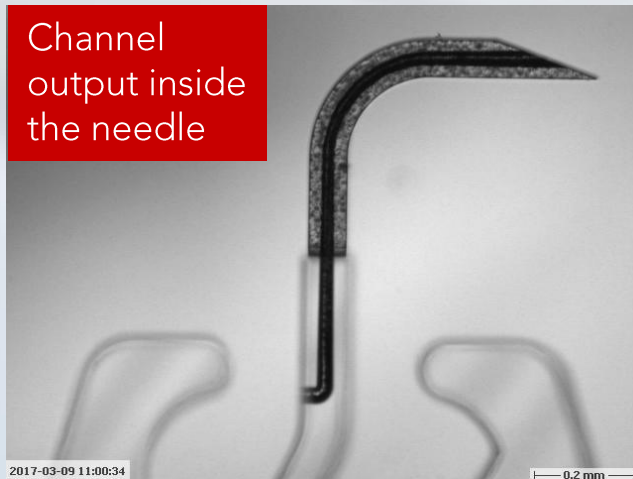
Flexural strength has been measured in literature as high as 2.7 GPa!

CASE STUDY OF A MEDICAL DEVICE

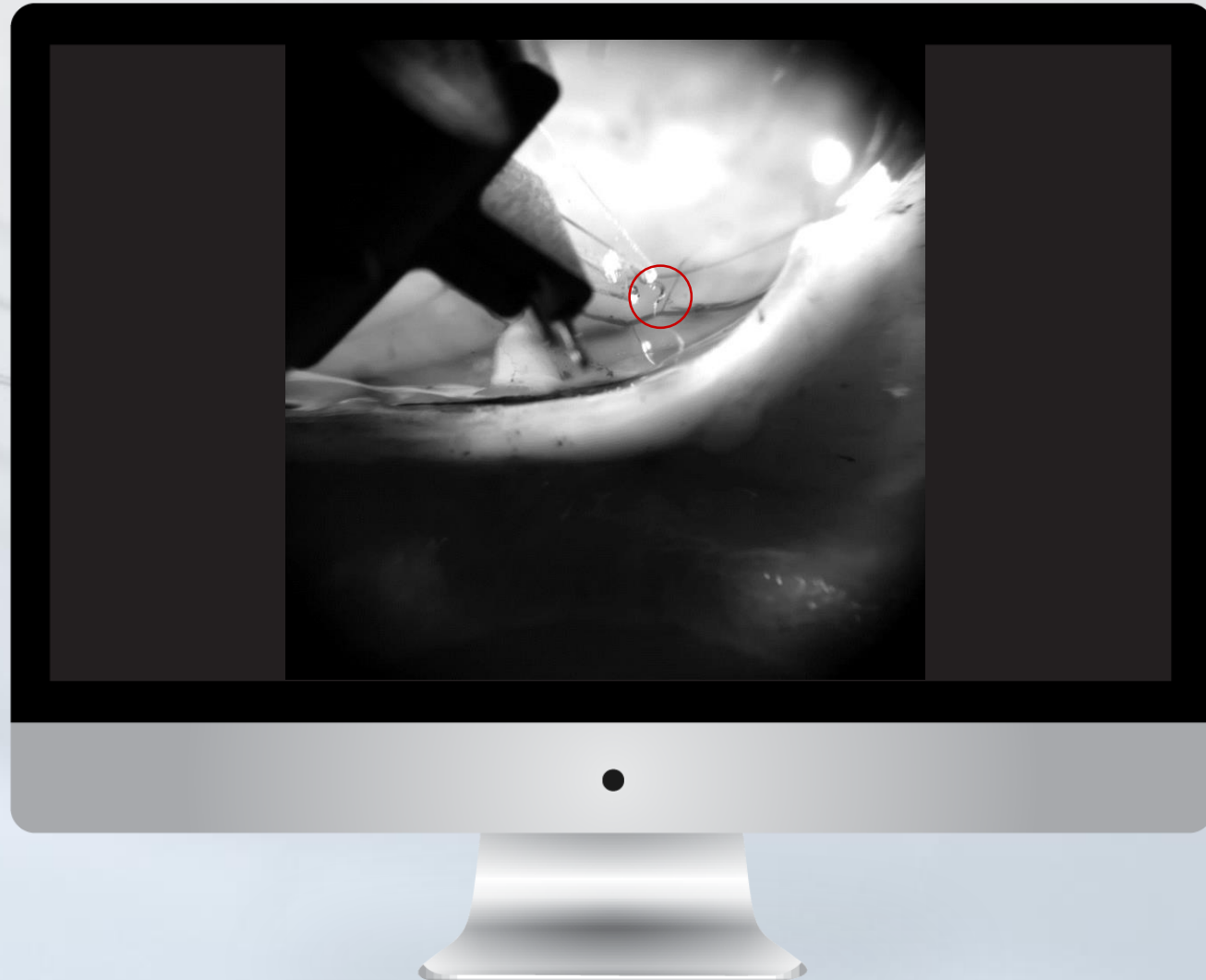
The puncture is activated through a bi-stable element



Elastic actuation system



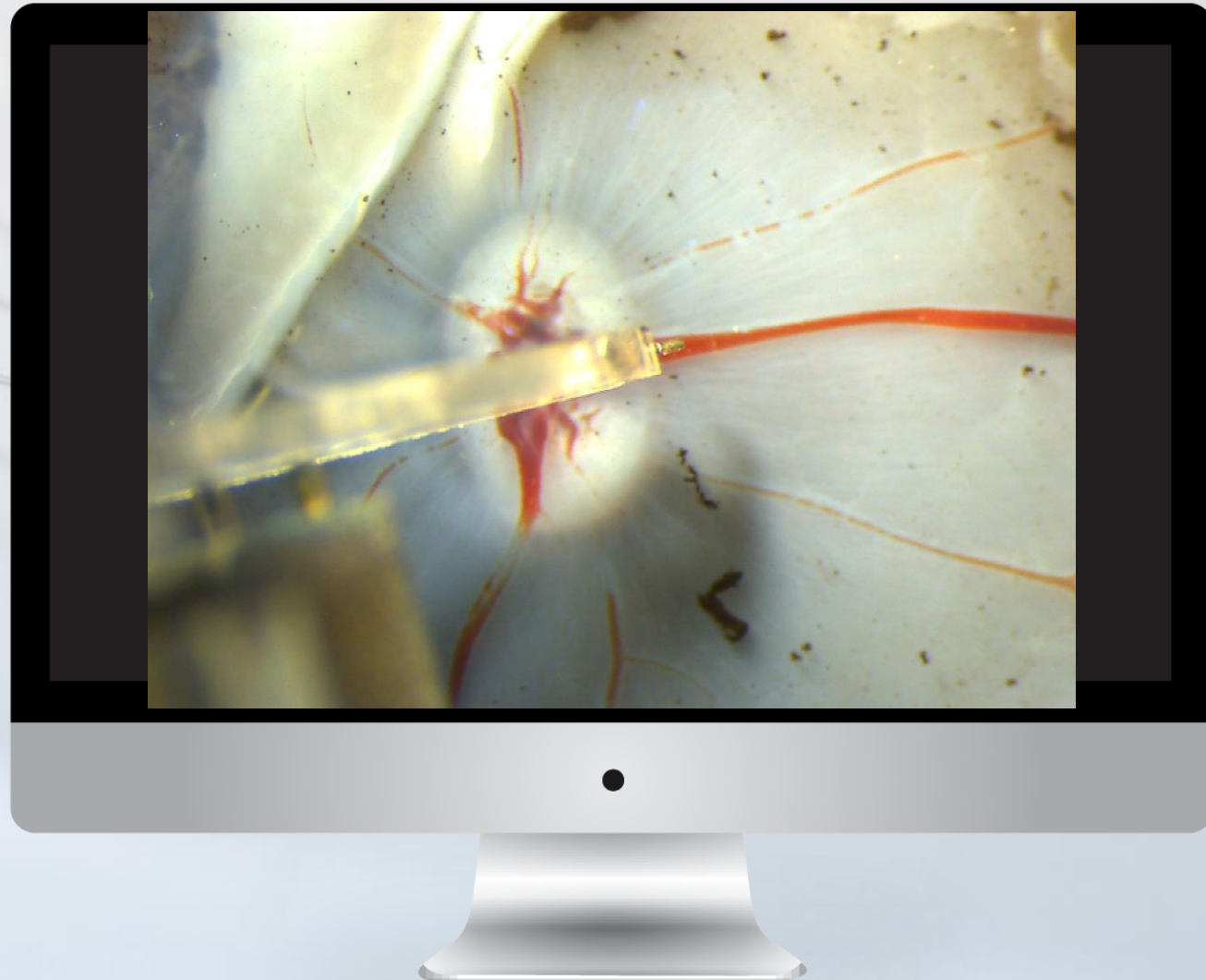
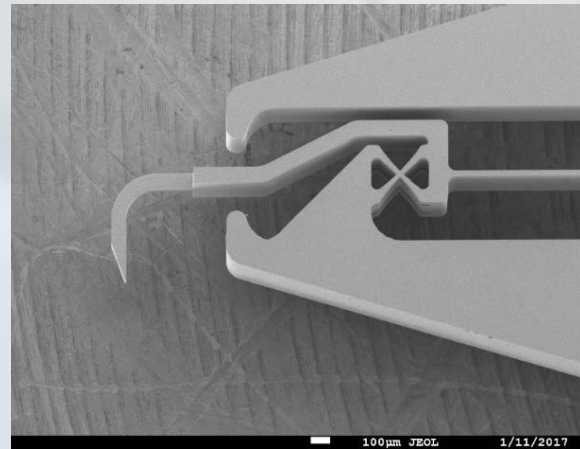
Channel output inside the needle



MEDTECH & LIFE SCIENCE

Surgical tools

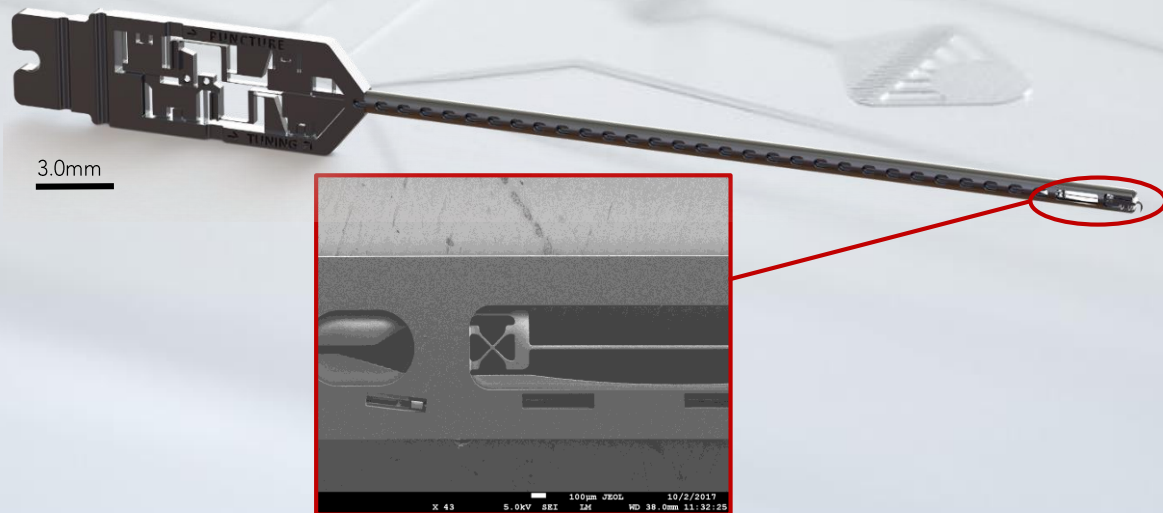
Micro needle integrating fluidic channels for minimal invasive surgery



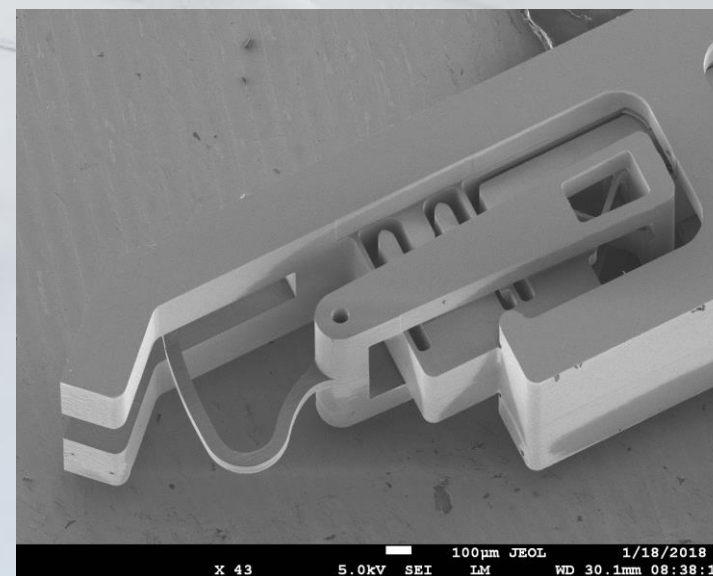
PROTOTYPE - VERSION 2

Additional functionalities:

1. 45mm long shaft for eye penetration (diameter 0.9mm)
2. Packaging
3. Mechanical amplification stages for external actuation
4. More advanced needle shape
5. Feet for tool positioning and stabilization around the vein



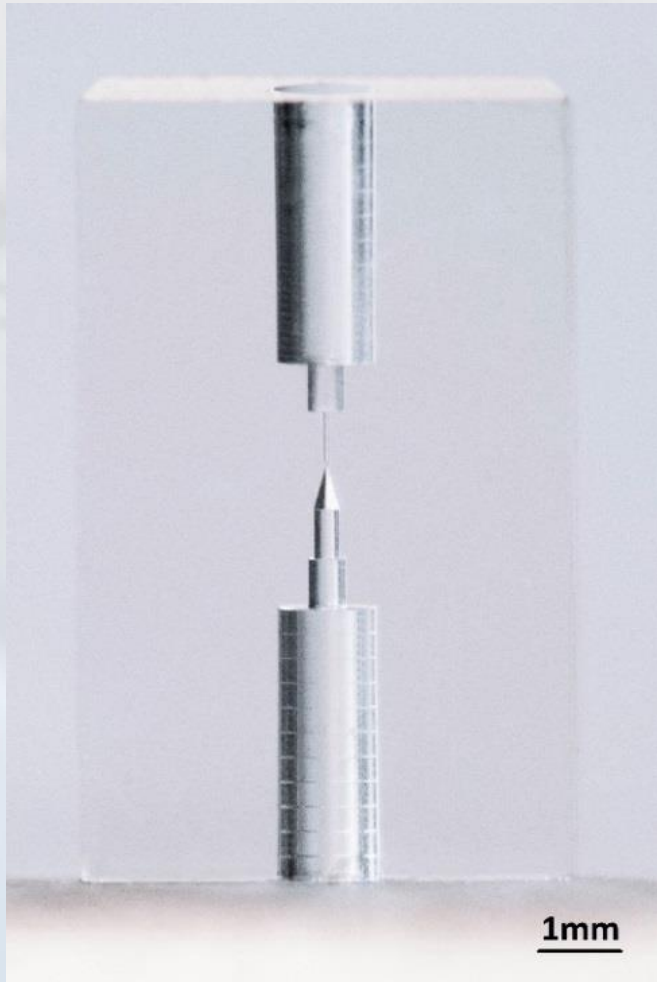
Patent pending



PROTOTYPE - VERSION 2

MEDTECH & LIFE SCIENCE

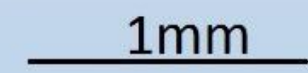
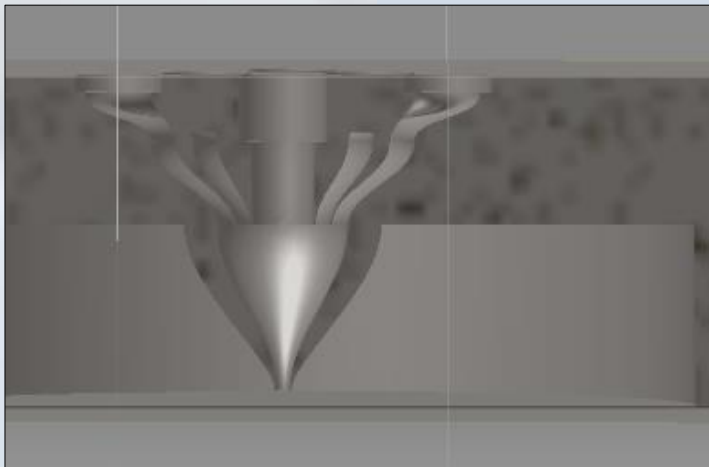
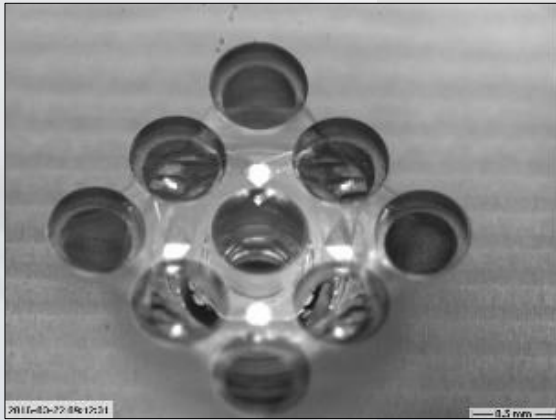
3D Medical Device
Fluidic connector



Thickness: 4mm
Length: 10mm
Cavity diameter: 20um
Material: fused silica

MEDTECH & LIFE SCIENCE

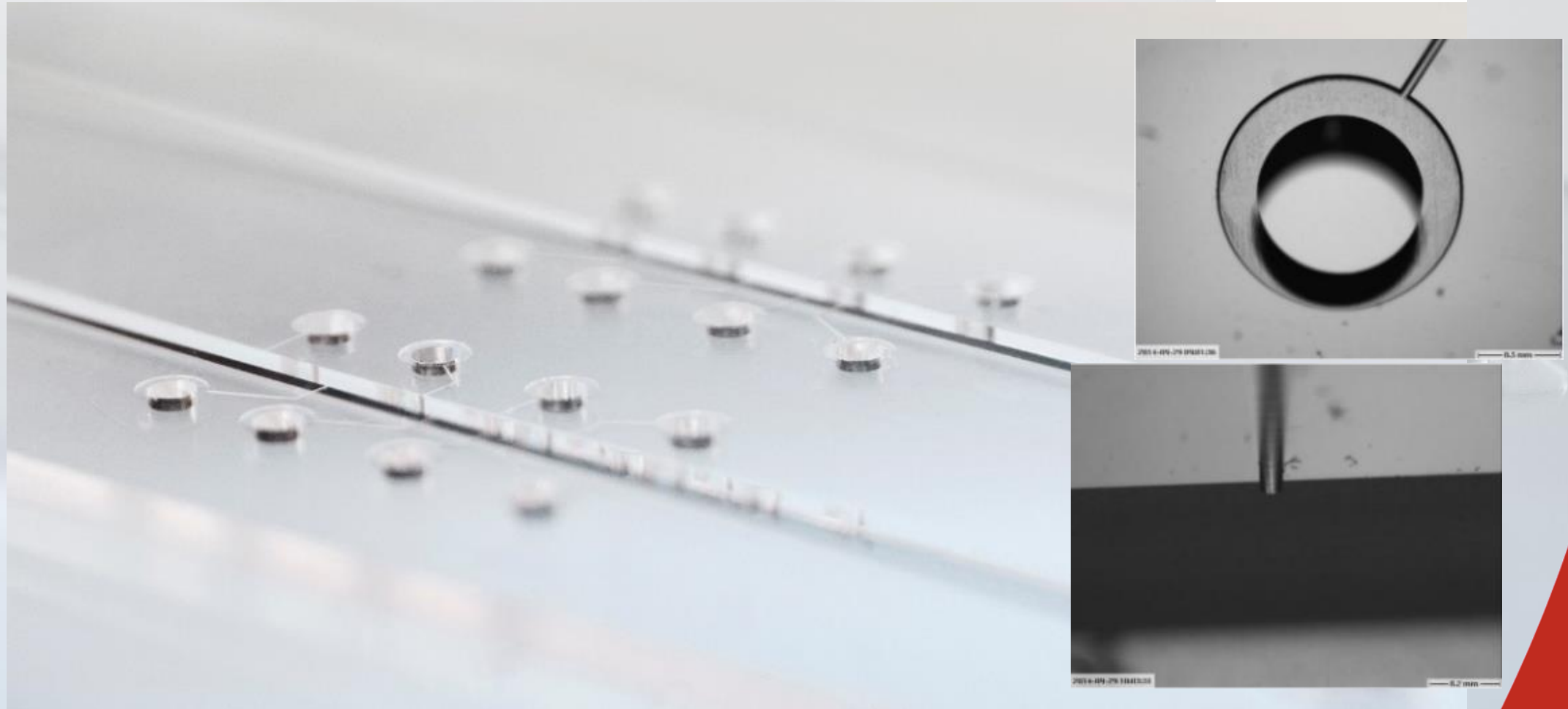
3D Medical Device
Mixers



MEDTECH & LIFE SCIENCE

3D Microfluidic Device

Multilevel microfluidic chips with integrated access holes



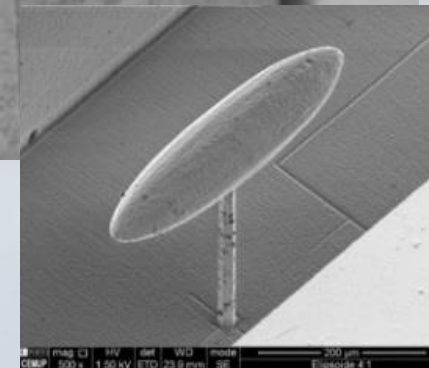
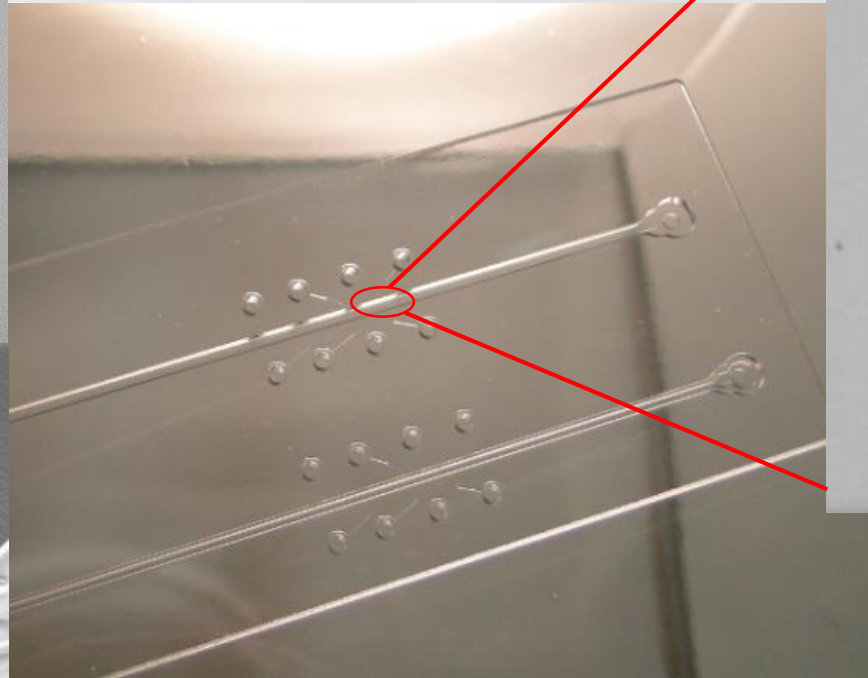
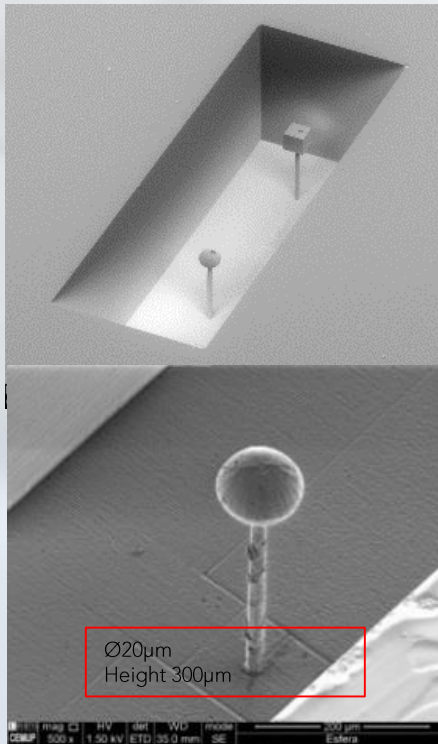
L. Campo-Deaño, S. Martínez-Aranda and F.J. Galindo-Rosales

Financial support from FCT, COMPETE and FEDER through project EXPL/EMS-TRA/2306/2013 and grants IF/00148/2013 and IF/00190/2013.

MEDTECH & LIFE SCIENCE

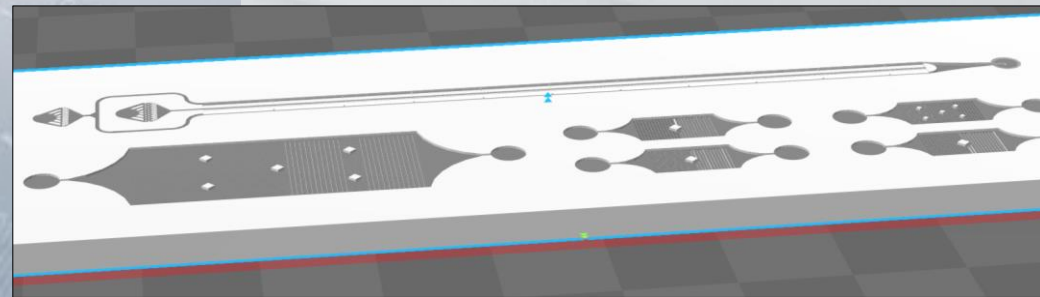
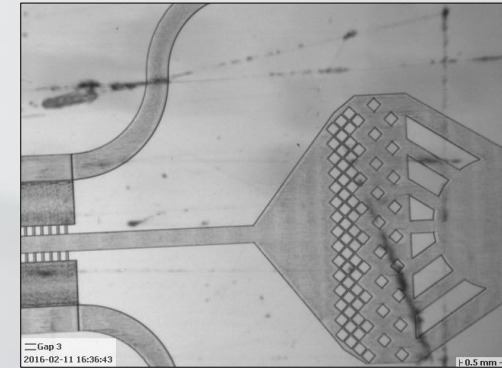
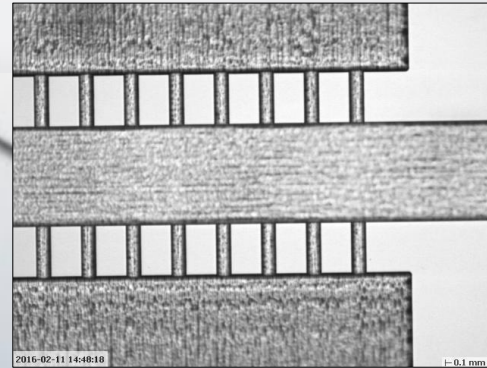
3D Microfluidic Device

Different 3D targets (MICROBOTS) inside a microfluidic device



MEDTECH & LIFE SCIENCE

3D complex lab-on-a-chip

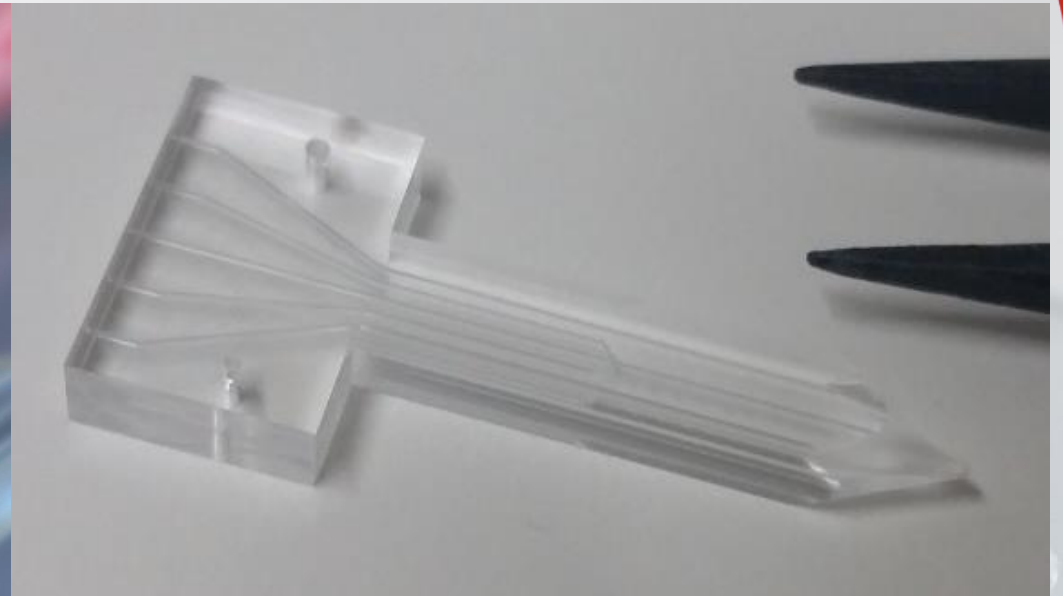
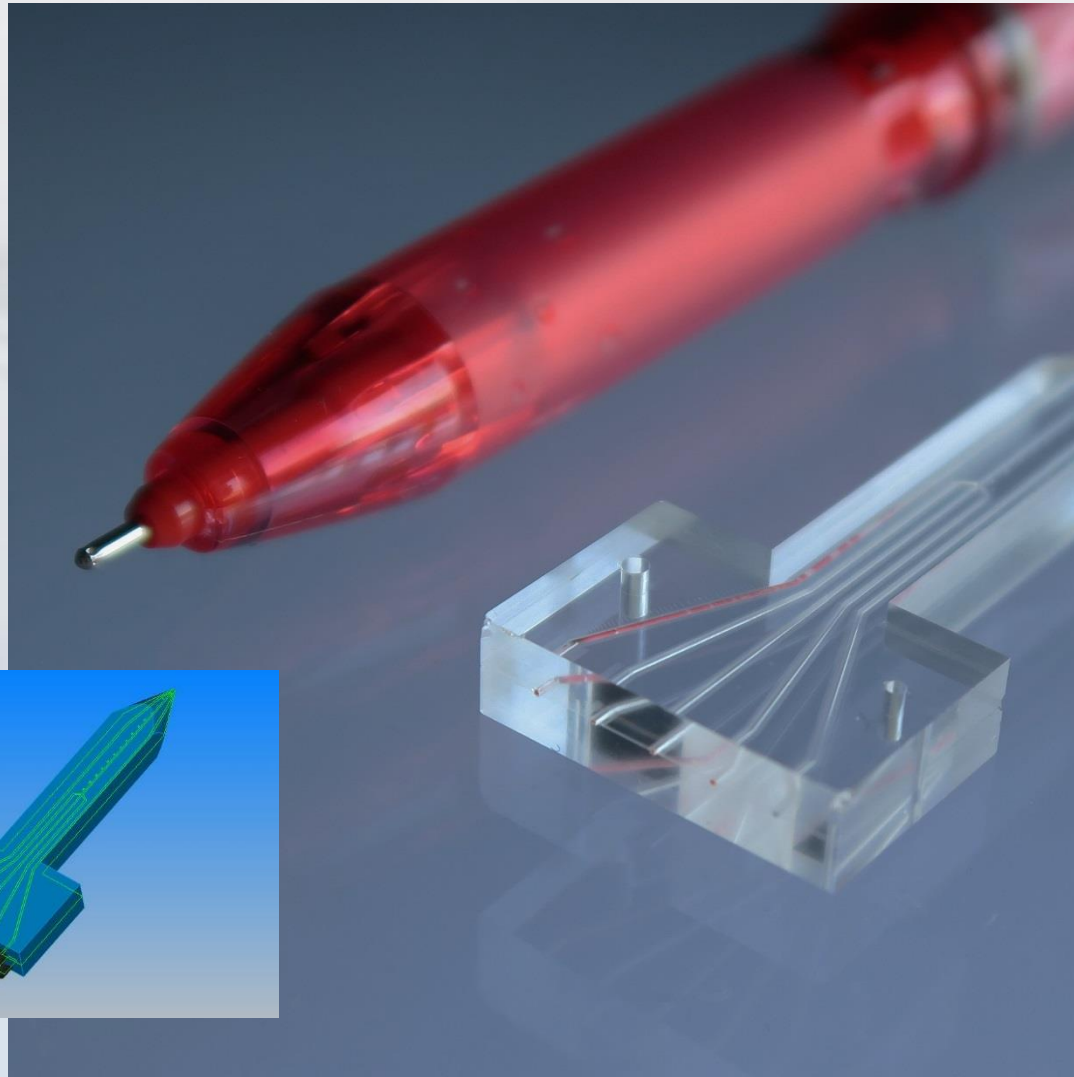


Overall channel length : ~15 cm
Smallest channel diameter: 3 μ m
Surface quality: Ra < 100 nm
Material: fused silica

Courtesy of Leibniz Institute – HKI in Jena, Germany – Dr. Oksana Schvydkiv

MEDTECH & LIFE SCIENCE

Glass-to-glass encapsulation / Welded chips



Channels length: 30 mm
Channels diameter: 100 μm
Cross-section: Square
Thickness: 4 mm
Nozzle outlet: 100 μm
Material: fused silica

MICROMECHANICS

3D Mechanics and optics
Flexures

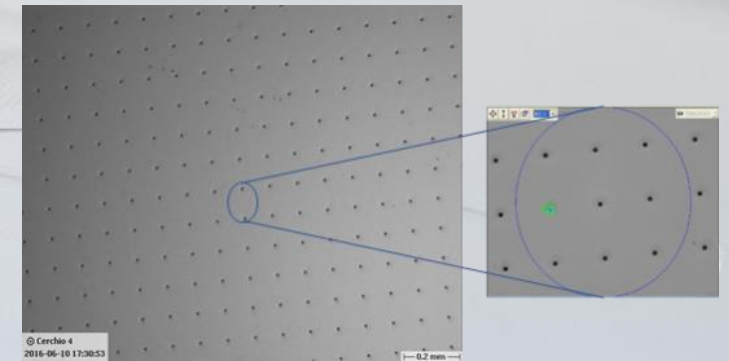
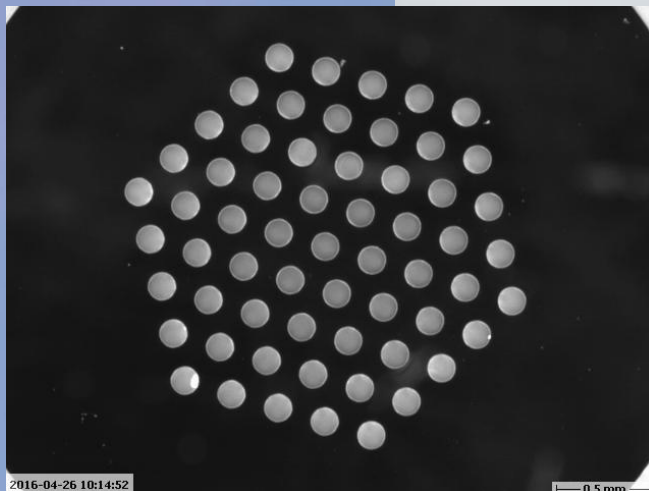
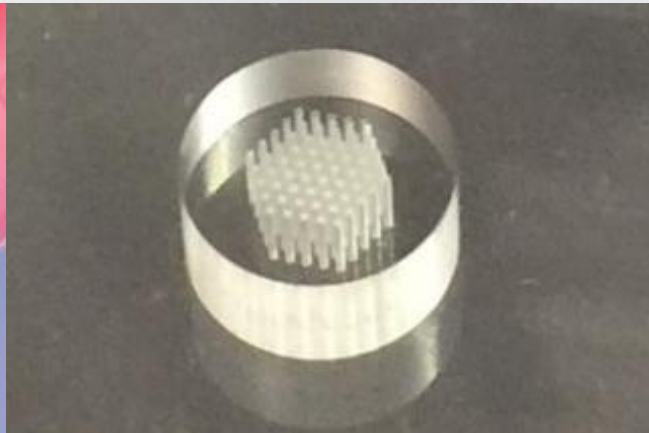


OPTICS & PHOTONICS

Passive alignment plates

Aperture grid

Passive alignment systems, pinholes



Thickness: 3 mm

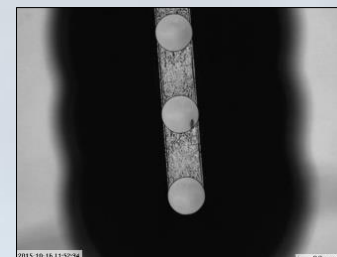
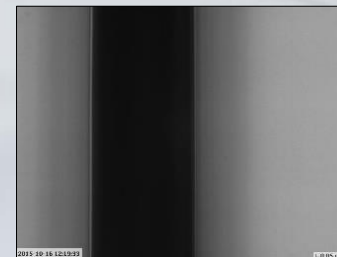
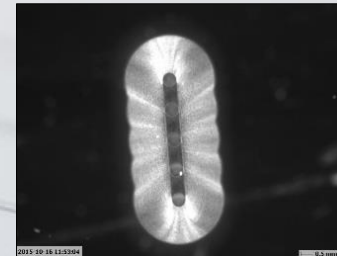
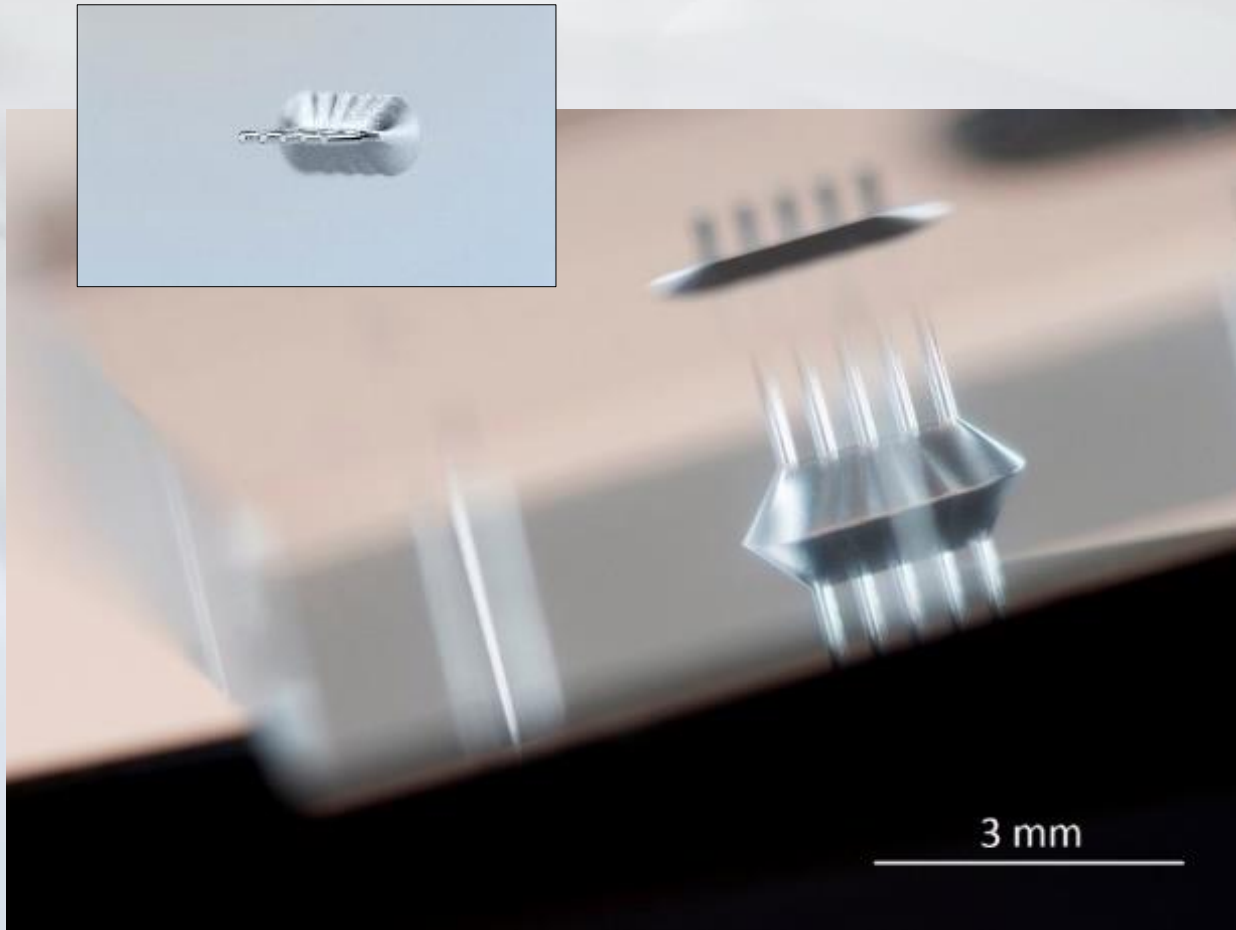
Center-to-center: 250 μm

Cavity diameter: 128 to 140 μm

Material: fused silica

OPTICS & PHOTONICS

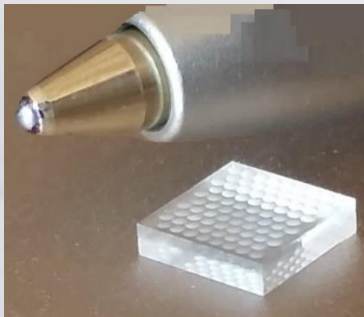
Passive alignment plates
V-grooves through holes



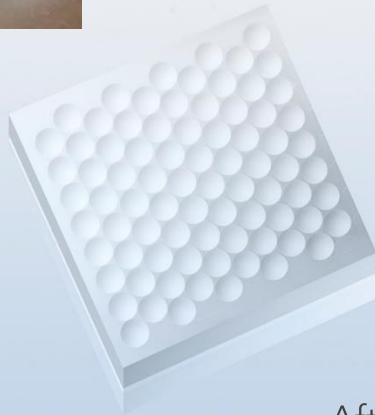
Thickness: 2 mm
Taper depth: 440 μm
Cavity diameter: 126 μm
Material: fused silica

OPTICS & PHOTONICS

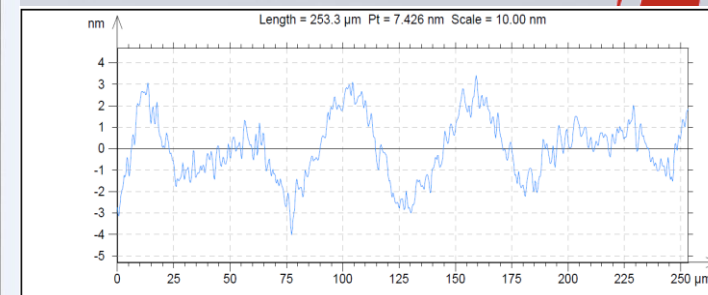
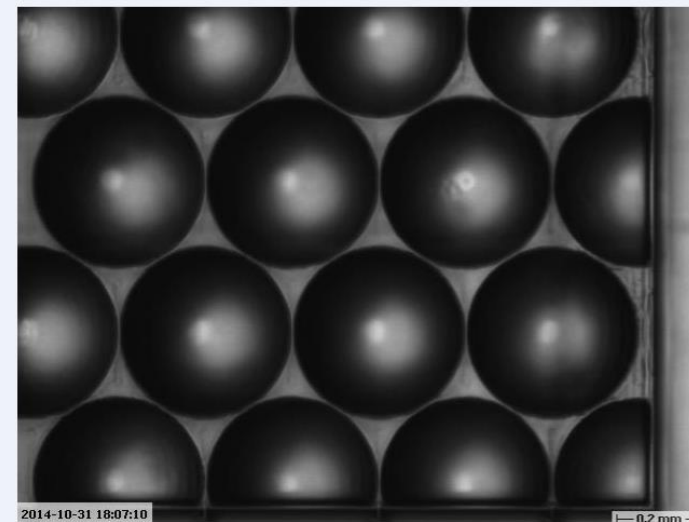
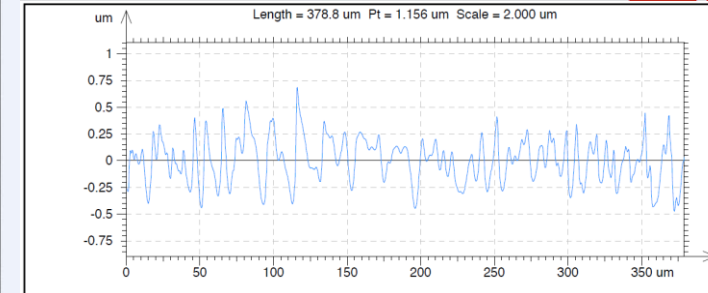
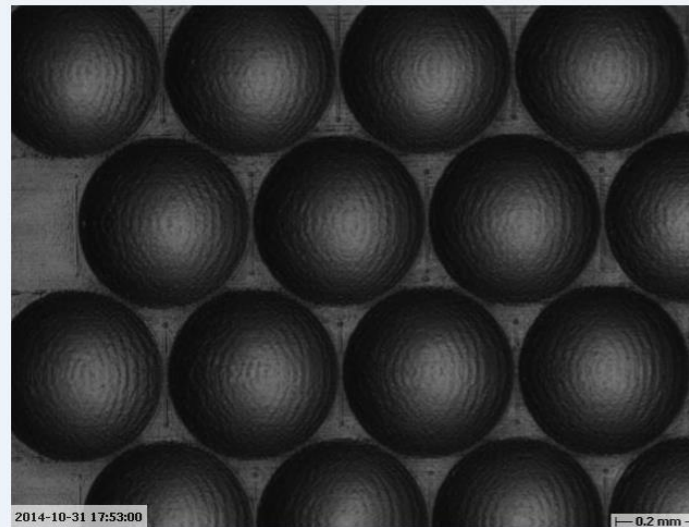
Microlenses for imaging & illumination



Before polishing $RA < 100\text{nm}$

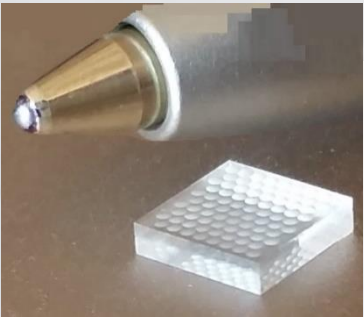


After polishing $RA < 10\text{nm}$

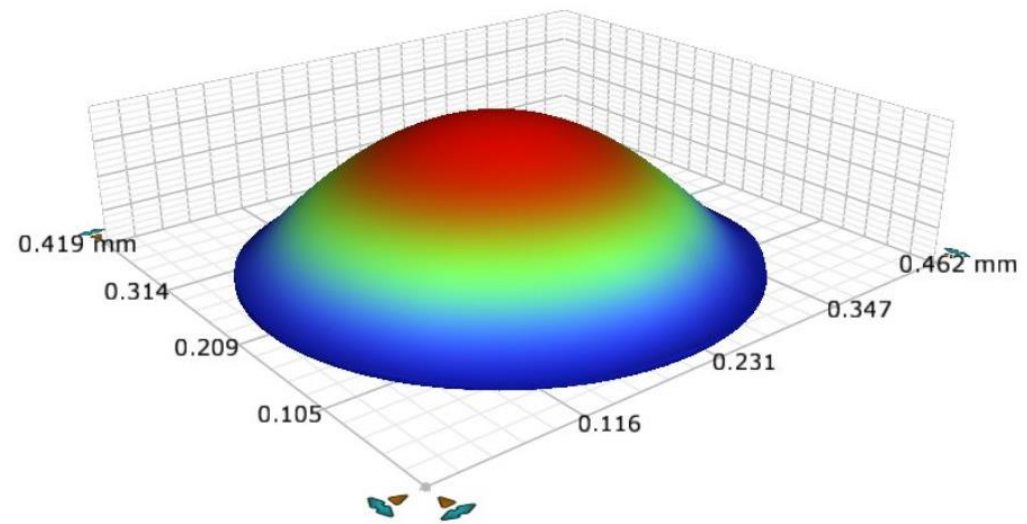
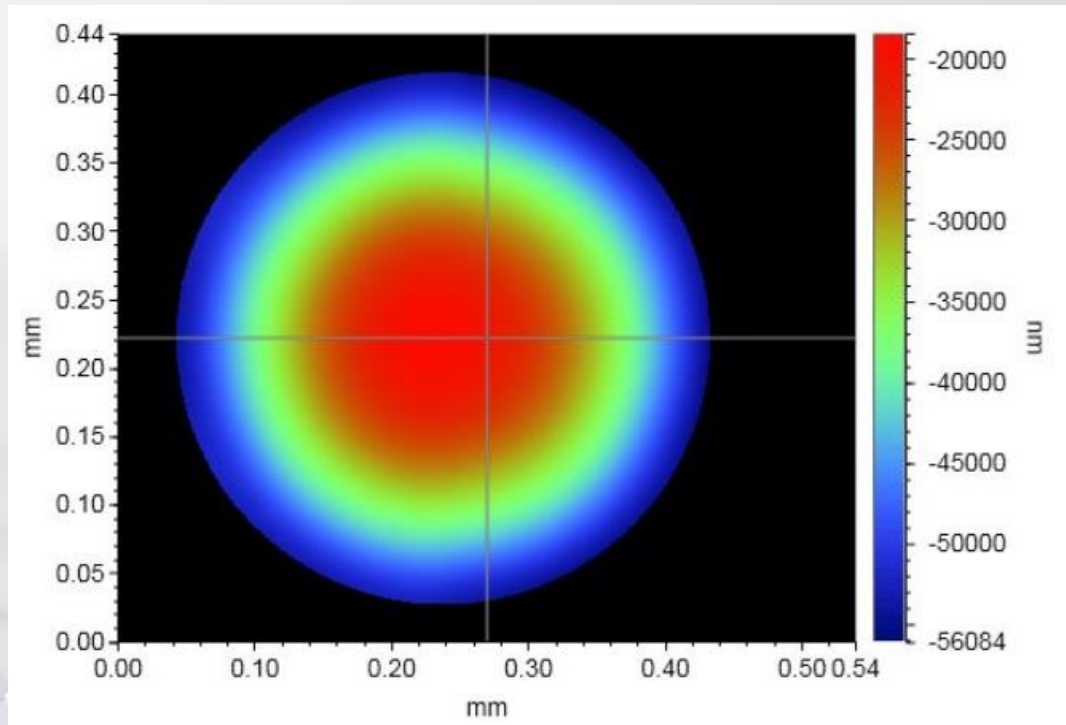


OPTICS & PHOTONICS

Microlenses for imaging & illumination

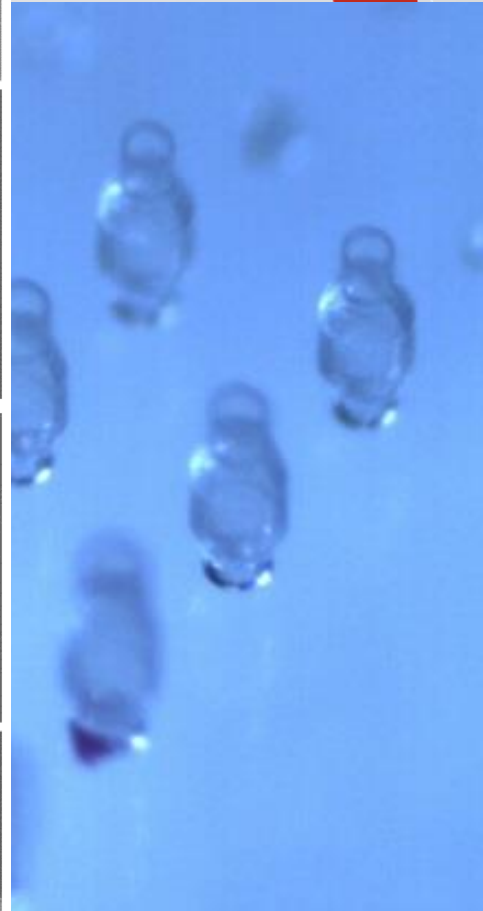
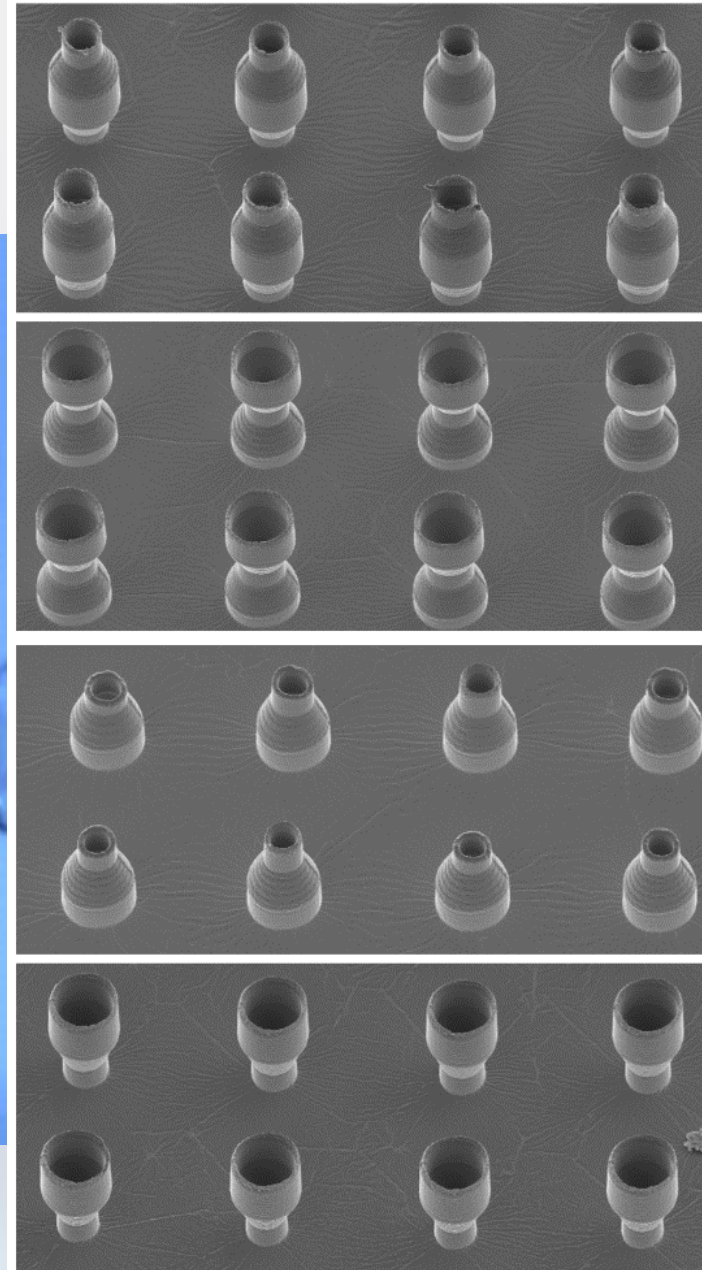
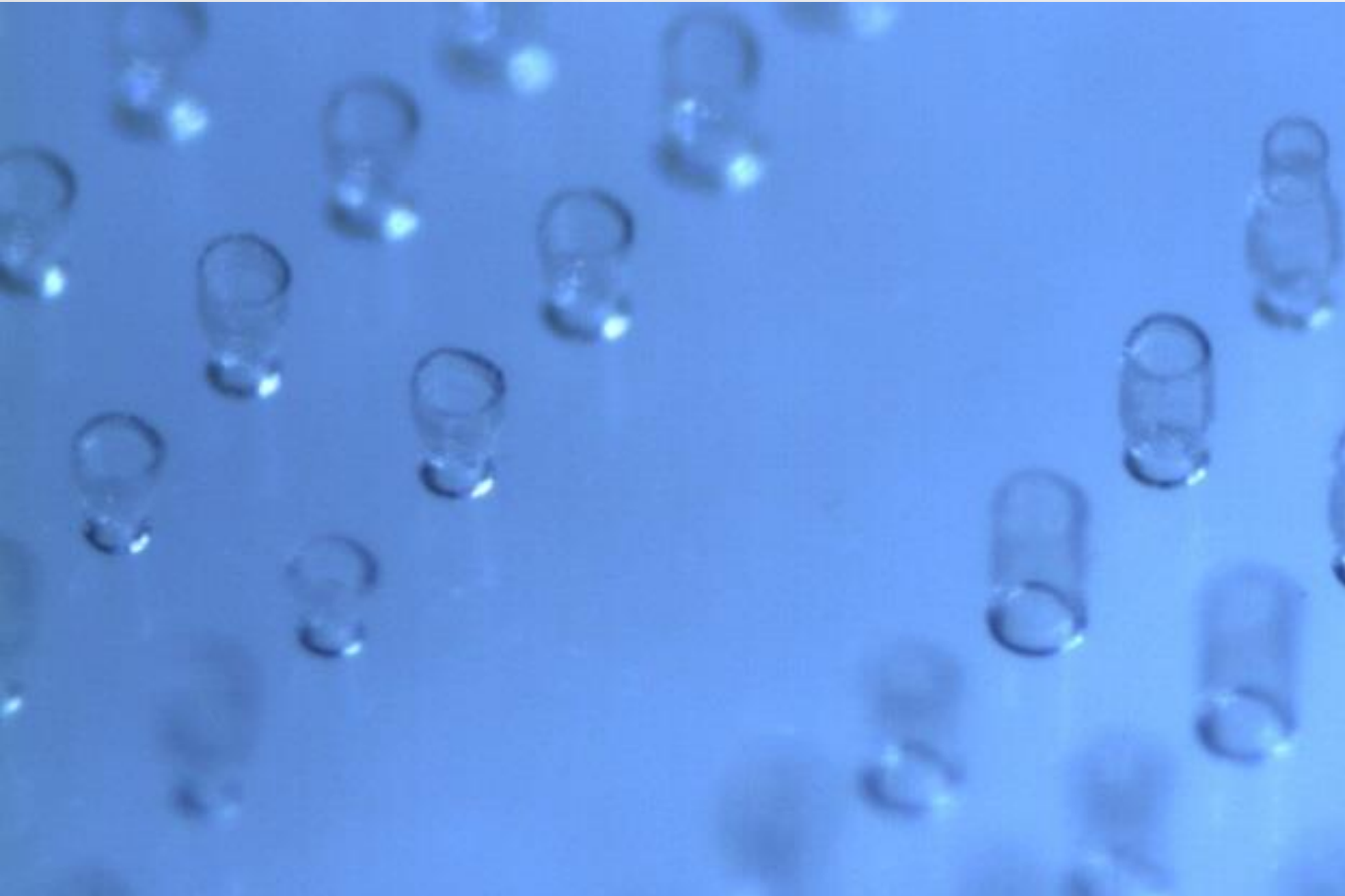


Main performances:
Controllable ROC & lens height
Low astigmatism
Low asymmetry
Homogenous surface

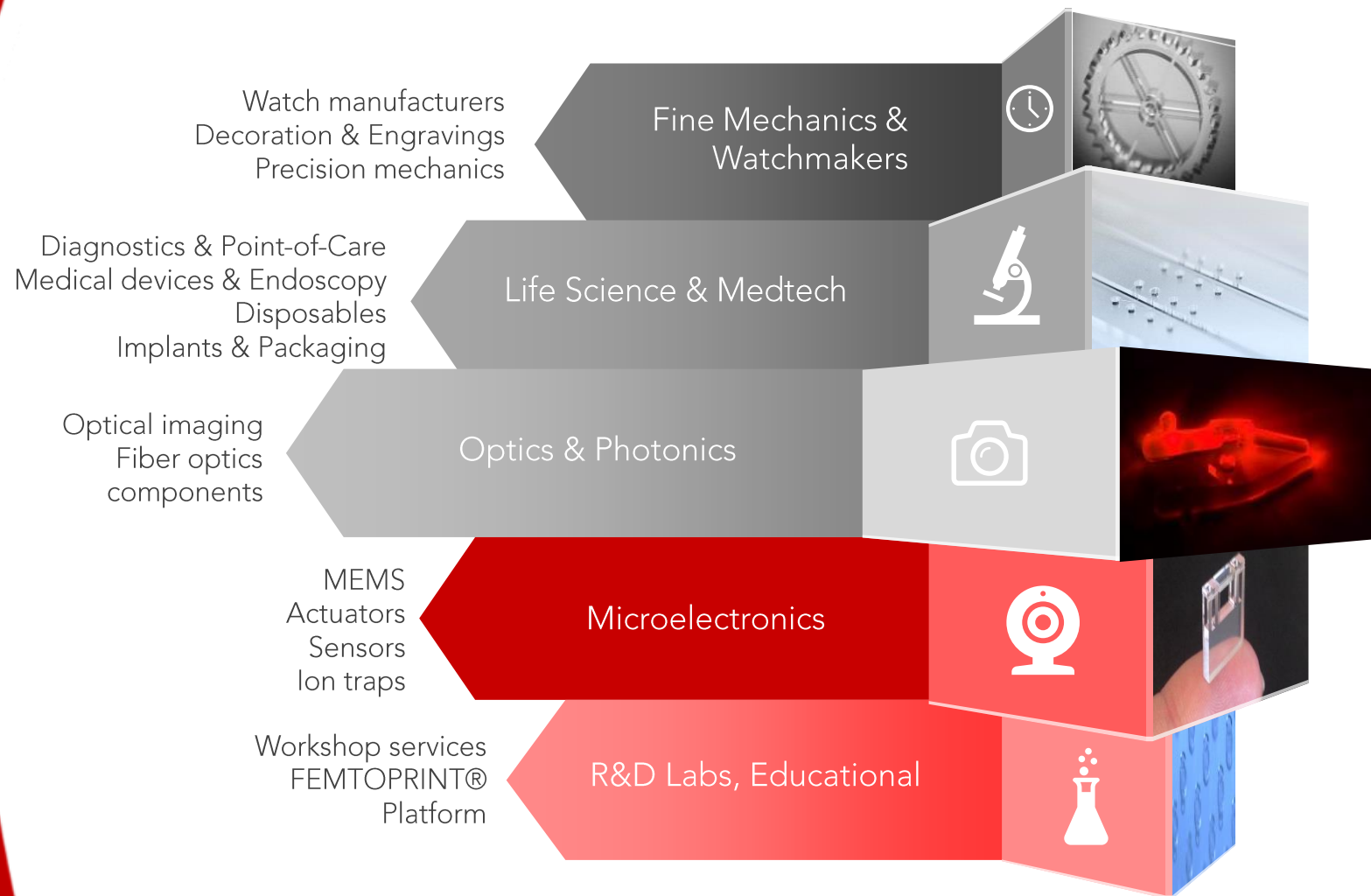


WHAT ABOUT POLYMERS?

3D Molds integration

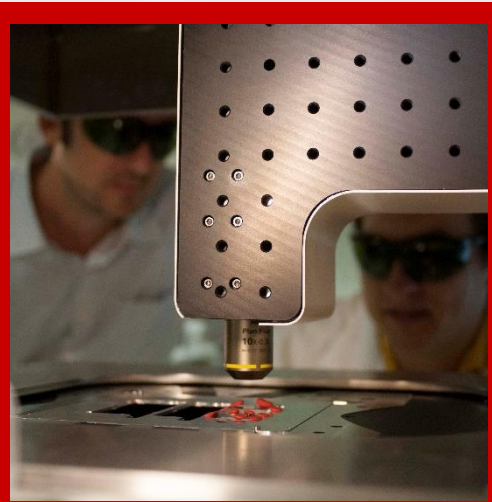


MARKETS



THE ORGANIZATION

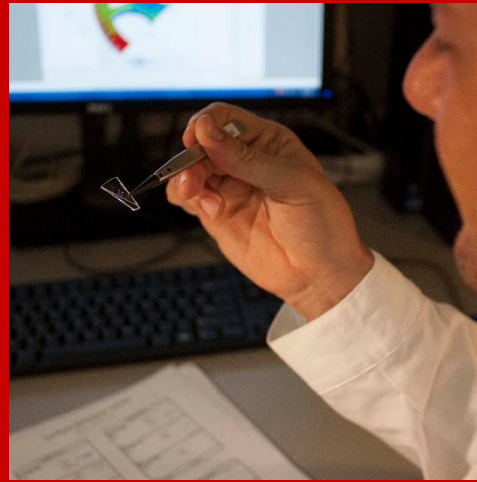
FEMTOprint Business Units:



FEMTOprint
SYSTEMS

FEMTOPRINT®
Microfabrication Platform

- 3D printing machines for academics
- 3D printing industrial solutions
- 3D printing platforms
- Maintenance services
- Training/Tutorials



FEMTOprint
SOLUTIONS

R&D Solutions

- R&D projects
- Design of new devices
- EU/Innosuisse/Community projects
- New process engineering



FEMTOprint
SERVICES

Contract Manufacturing Services

- Rapid prototyping
- Industrial production of 3D micro devices
- Metrology and quality inspections

GLOBAL PRESENCE



HQ **01**

Lugano, Switzerland



Export **02**

25+ Countries



Distributors **03**

5 in 3 Continents



Customers **04**

250+ active partners



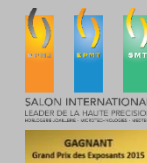
NDA **05**

200+ active agreements



AWARDS

- ✓ **Best Project Finalist Award** at the EuroNanoForum in Dublin, Jun 2013
- ✓ Finalist of **Innovation Award Laser Technology** in Aachen, May 2014
- ✓ Finalist of **Prism Awards 2015** at SPIE Photonics West in San Francisco, Feb 2015
- ✓ Winner of **Grand Prix 2015** at Salon EPHJ – EPMT – SMT in Geneva, Jun 2015
- ✓ Winner of **Photonics Award**, 3D printing category at Laser World of Photonics in Munich, Jun 2015
- ✓ Finalist of **Swiss Technology Award 2015** in Basel, Nov 2015
- ✓ Winner of **CTI International Entrepreneur Award** at Masschallange Summit 2016 in Geneva, Feb 2016
- ✓ Nominee of **W.A. De Vigier Foundation Award** in Solothurn, May 2016
- ✓ Finalist of **OptecNet Start-up Challenge** in Frankfurt, Jun 2016
- ✓ Runner-up in the **Best Start-up of the Year Competition** at International MicroNanoConference, Amsterdam, Dec 2017



GAGNANT
Grand Prix des Exposants 2015

FEMTOprint

3D printing for glass microdevices

→ VISIT US AT OUR BOOTH N88 ←



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6933 Muzzano
Switzerland



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info@femtoprint.ch



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CREATIVITY IS
 THE **ENGINE**