FEMTOprint

FEMTOPRINT® – Mechanics, fluidics, optics meet in a monolithic 3D micro device out of glass

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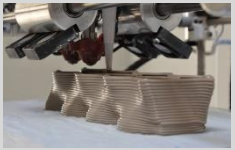
SWISS PHOTONICS

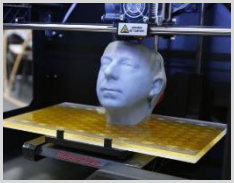
INDEX

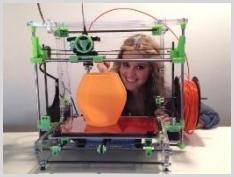
- 3D PRINTING
- FEMTOPRINT® TECHNOLOGY
- APPLICATIONS
- POLISHING
- CONCLUSIONS

3D PRINTING

Have heard about 3D printing?

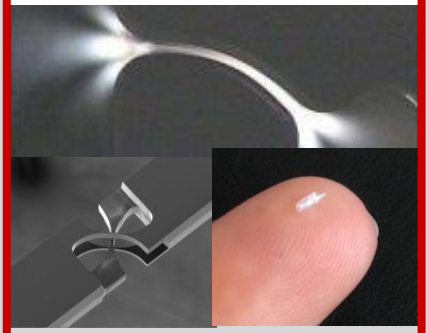






additive
manufacturing

FEMTOprint



subtracting
manufacturing

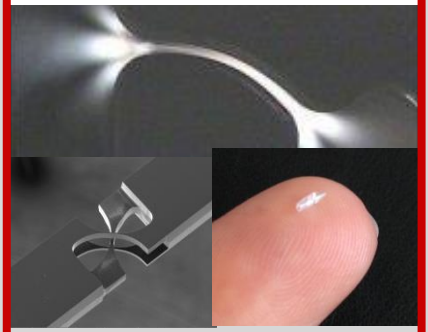
3D PRINTING

Have heard about 3D printing?

Pillar ϕ5mm

Pillar ϕ20 µm

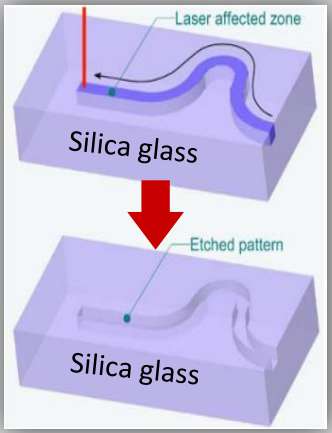
FEMTOprint



subtracting
manufacturing

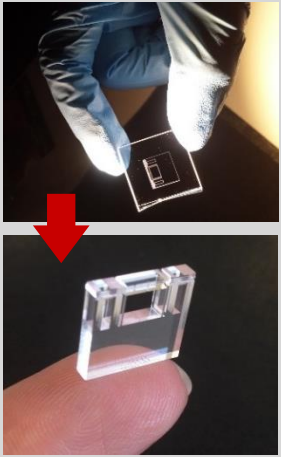
FEMTOPRINT® TECHNOLOGY

Selective subtracting manufacturing



Laser exposure

Chemical etching

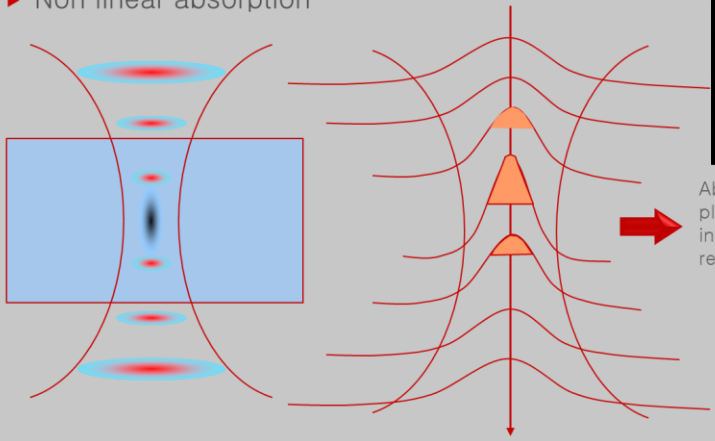


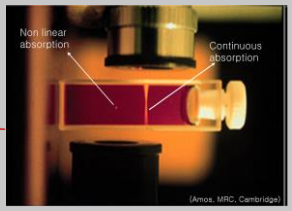
FEMTOPRINT® TECHNOLOGY

How it works

For transparent material, the energy can be absorbed in the bulk!

- Non linear absorption





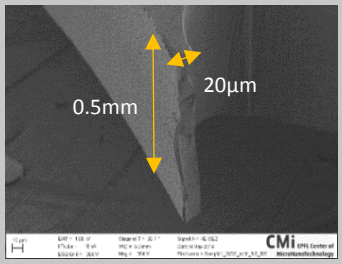
Absorption only takes place if a focused intensity threshold is reached

FEMTOPRINT® TECHNOLOGY

Process parameters

Resolution and tolerances

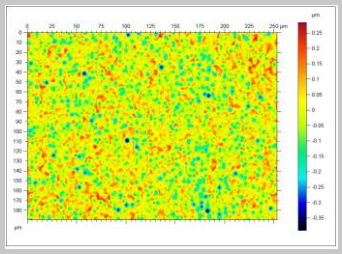
- Process resolution 1µm
- Tolerances for 3D parts ±2µm
- Aspect ratio >> 1:50
- Repeatability 1µm



Surface quality

- After etching Ra < 80nm
- No laser writing pattern visible
- Polishing available for Ra < 10nm

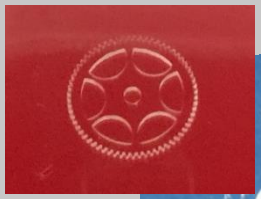
ISO 25178			
Height Parameters			
Sq	0.08174	µm	*Root mean square height*
Sp	0.2843	µm	*Maximum peak height*
Sv	0.3898	µm	*Maximum pit height*
Sz	0.6741	µm	*Maximum height*
Sa	0.06446	µm	*Arithmetic mean height*

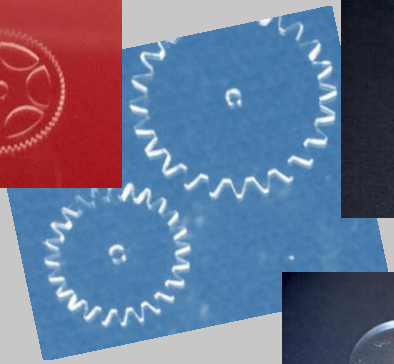


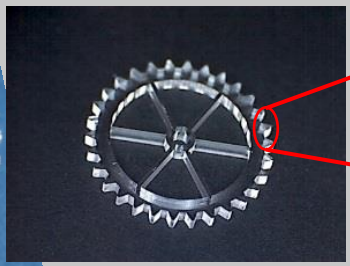
APPLICATIONS

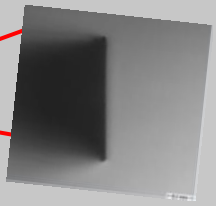
2.5D Micromechanics Devices

Transparent movements for watches

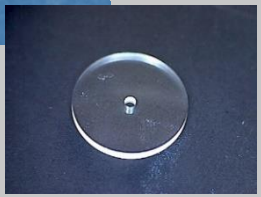








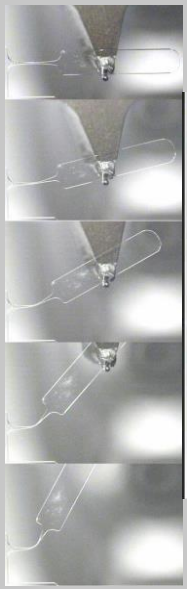
Very smooth sidewalls!



Thickness: 0.5mm
Material: fused silica

APPLICATIONS

Micromechanics



Fused silica flexure

Optical Materials Express, 1, 816-831 (2011)

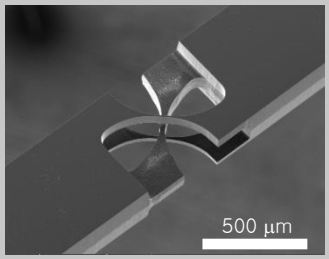
APPLICATIONS

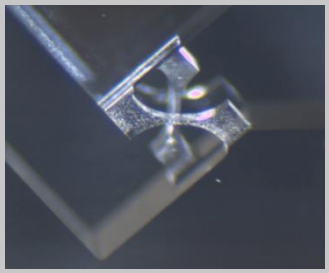
Micromechanics

3D Mechanical devices

Hinges

Galatea Project (TU/e) (2013)



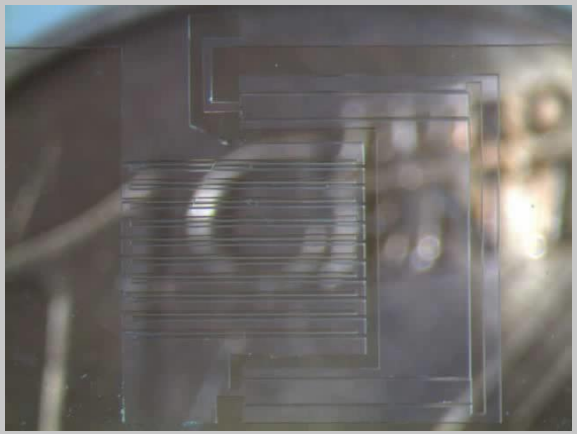


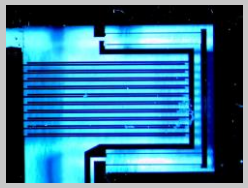
APPLICATIONS

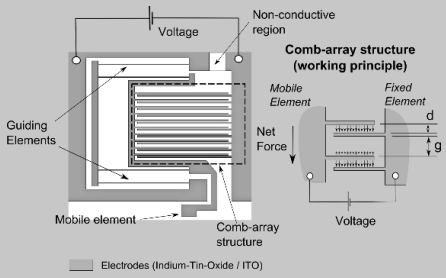
Micromechanics

MEMS

Sensors, Actuators







Thickness: 0.5mm

Material: fused silica

Bo Lenssen and Yves Bellouard, Appl. Phys. Lett. **101**, 103503 (2012)

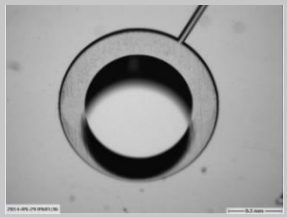
APPLICATIONS

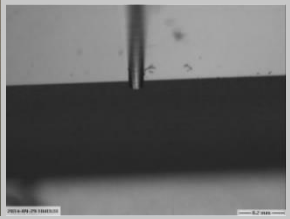
Microfluidics – Biomed

3D Microfluidic device for cells analysis

Multilevel microfluidic chip with integrated access holes

U.PORTO
FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO





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.

APPLICATIONS

Microfluidics – Biomed

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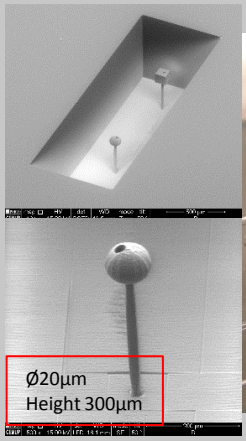
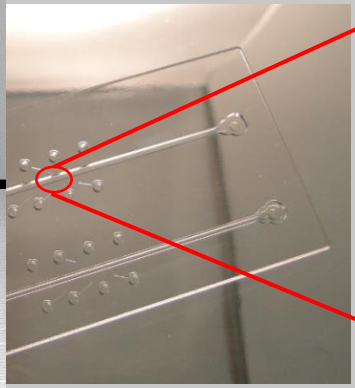
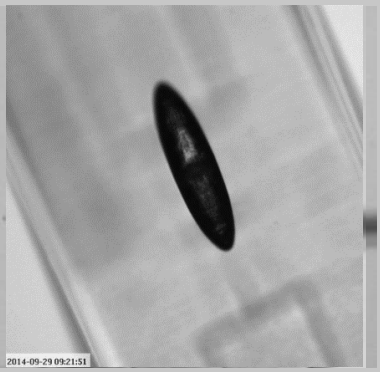
3D Microfluidic Device

3D Targets inside microfluidic devices







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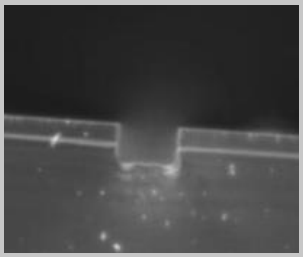
APPLICATIONS

Microfluidics – Biomed

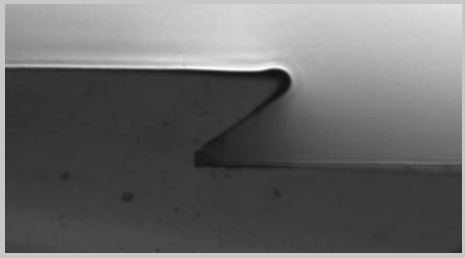
3D Microfluidic Device

The sidewalls can be fully controlled

- Straight sidewalls channel



- Tilted sidewalls channel

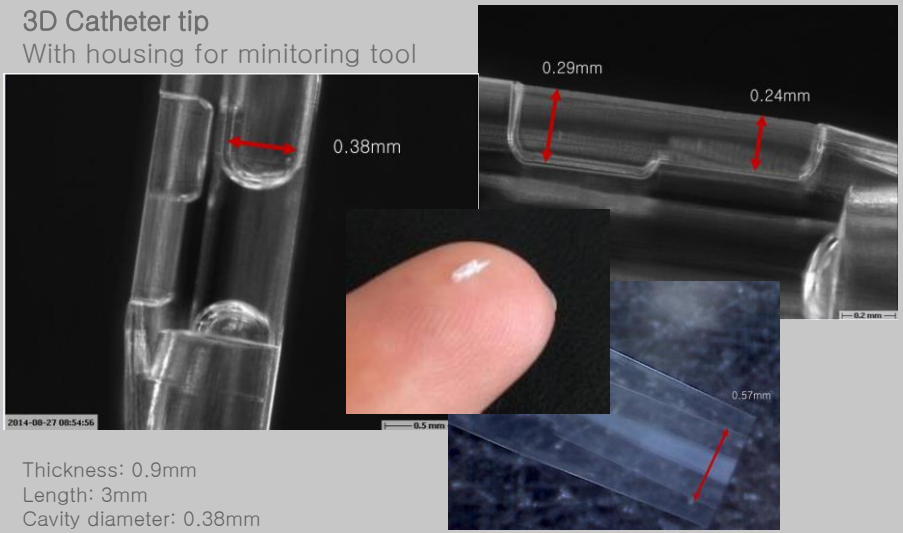


APPLICATIONS

Microfluidics – Biomed

3D Catheter tip

With housing for minitoring tool



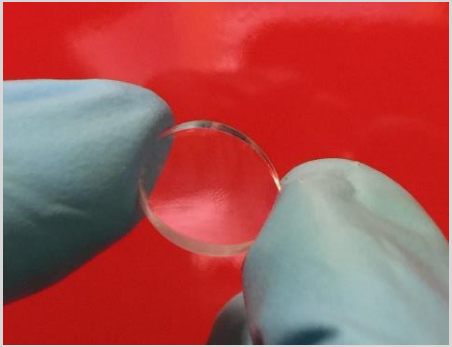
Thickness: 0.9mm
Length: 3mm
Cavity diameter: 0.38mm
Material: fused silica

APPLICATIONS

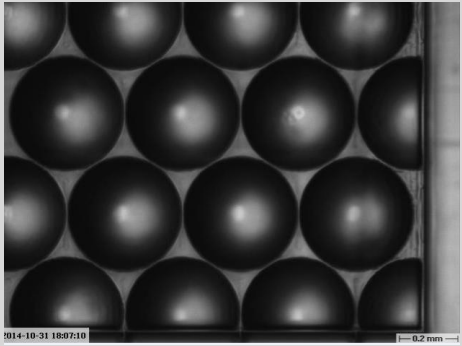
Optics – Lenses

Macro lens

For optical microscopes

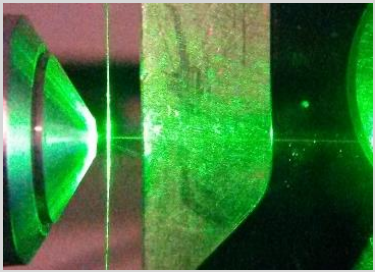


Microlenses



APPLICATIONS

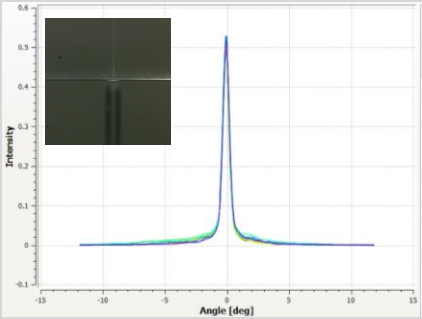
Optics – Waveguides



- Fabrication of optical devices
- Integration within existing microfluidic or mechanical devices for sensing

Performances

- Resolution 2µm (XY), 8µm (Z)
- Refractive index increase > 0.01
- Losses < 0.1dB/cm

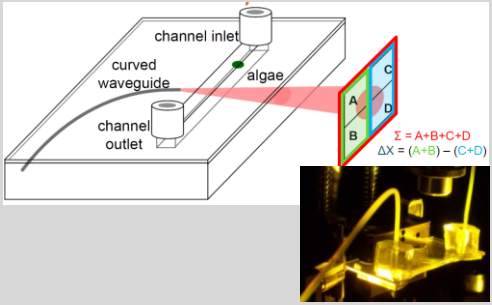


APPLICATIONS

Optics – Waveguides

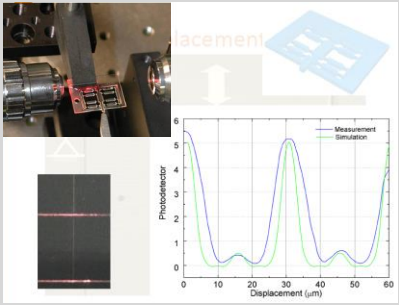
- Examples of devices exploiting waveguide detection

Microfluidics



A. Schaap et al. Biophotonics 672, 661–672 (2012)

Micromechanics



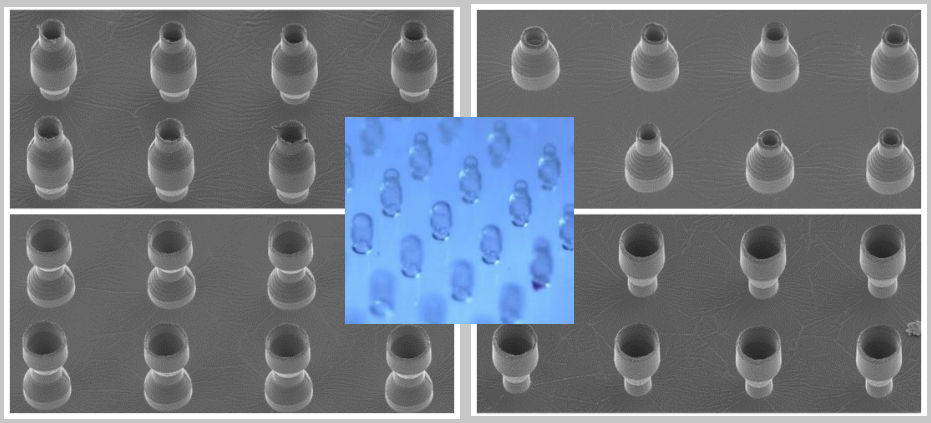
Y. Bellouard, A. Said, P. Bado, Opt. Express **13,** 6635–6644 (2005).

APPLICATIONS

Molding

3D Molds

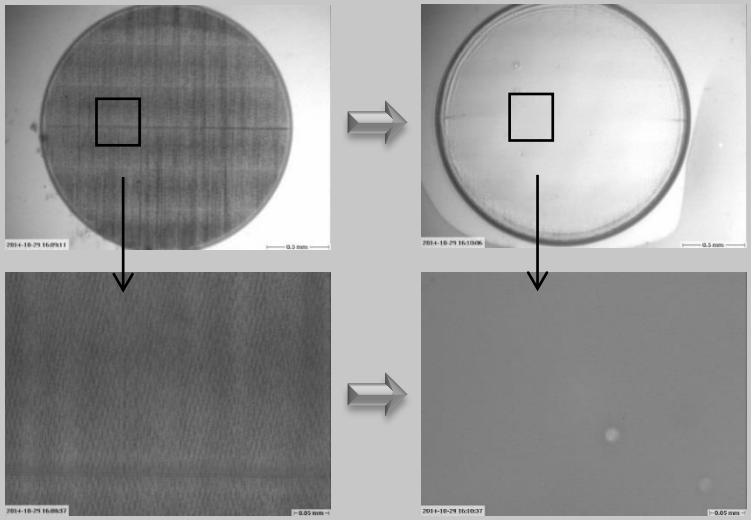
Large scale production



Allison Schaap and Yves Bellouard, Optical Materials Express, **3**, pp. 1428–1437 (2013)

POLISHING

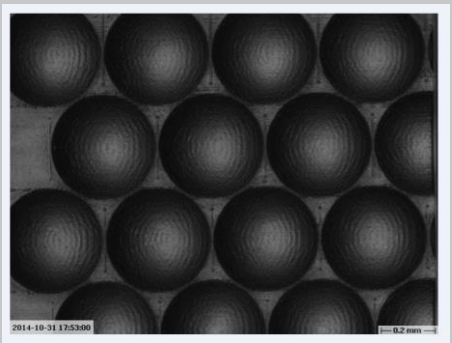
- The surface roughness of the parts after etching is ~80nm
- Polishing allows to go down to optical quality

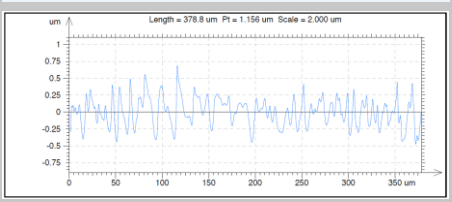


APPLICATIONS

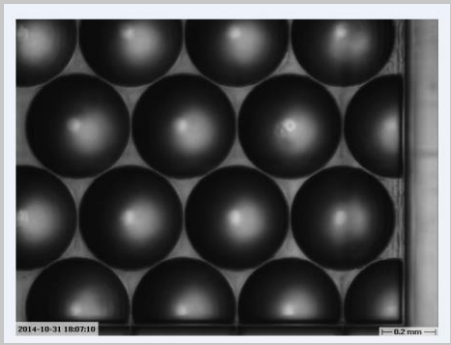
Microlenses

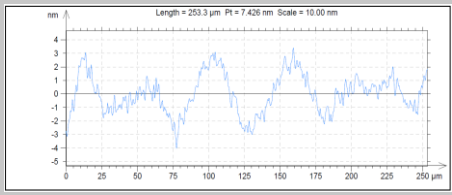
- Before





- After





CONCLUSIONS

- ✓ The technology is applicable to a wide range of «transparent» materials (fused silica, borofloat, sapphire, ruby, polymers).
- ✓ The technology is well adapted for micro rapid prototyping but also for series (mass production).

Meet with FEMTOprint at Stand Nr. K97

FEMTOprint

Enabling innovation with multi feature 3D micro devices out of glass.

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