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

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3D PRINTING

Have heard about 3D printing?

additive manufacturing

subtracting manufacturing

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3D PRINTING
Have heard about 3D printing?

FEMTOprint
subtracting manufacturing

Pillar φ5mm
Pillar φ20 μm
FEMTOPRINT® TECHNOLOGY
Selective subtracting manufacturing

Laser exposure

Chemical etching

Silica glass
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

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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

APPLICATIONS
Microfluidics – Biomed

3D Microfluidic device for cells analysis
Multilevel microfluidic chip 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.

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APPLICATIONS
Microfluidics – Biomed

3D Microfluidic Device
3D Targets inside microfluidic devices

Ø20µm
Height 300µm

L. Campo-Deaño, S. Martínez-Aranda and F.J. Galindo-Rosales
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3D Microfluidic Device
The sidewalls can be fully controlled
- Straight sidewalls channel
- Tilted sidewalls channel
3D Catheter tip
With housing for monitoring 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

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

• Fabrication of optical devices
• Integration within existing microfluidic or mechanical devices for sensing
Examples of devices exploiting waveguide detection

- Microfluidics
- Micromechanics

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

APPLICATIONS

Molding

3D Molds
Large scale production

The surface roughness of the parts after etching is \( \sim 80 \text{nm} \)

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