Electronic Supplementary Material (ESI) for Reaction Chemistry & Engineering.


# Electronic Supporting Information

# Compact reactors architectures designed with fractals

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**Table S1. Lindenmayer notation for common 2D fractals.**

| Space-filling curve | Axiom | Reproduction rules |
|---|---|---|
| Moore | LFL+F+LFL | L = −RF+LFL+FR−<br>R = +LF−RFR−FL+ |
| Peano | X | X = XFYFX+F+YFXFY-F-XFYFX<br>Y = YFXFY-F-XFYFX+F+YFXFY |
| Peano_Gosper | X | X = X+YF++YF-FX--FXFX-YF+<br>Y=-FX+YFYF++YF+FX--FX-Y |
| Sierpinski | L--F--L--F | L=+R-F-R+<br>R=-L+F+L- |
| Square curve | X+F+X | X=XF-F+F-XF+F+XF-F+F-X |

**Table S2. Length and reactor volume of different pseudo-orders of a 3D Hilbert curve with step length of 5 mm.**

| Pseudo order | Curve length [mm] | Reactor volume [mm$^3$] |
|---|---|---|
| 1 | 35 | 125 |
| 2 | 315 | 3375 |
| 3 | 2555 | 42875 |
| 4 | 20475 | 421875 |
| 5 | 163835 | 3723875 |

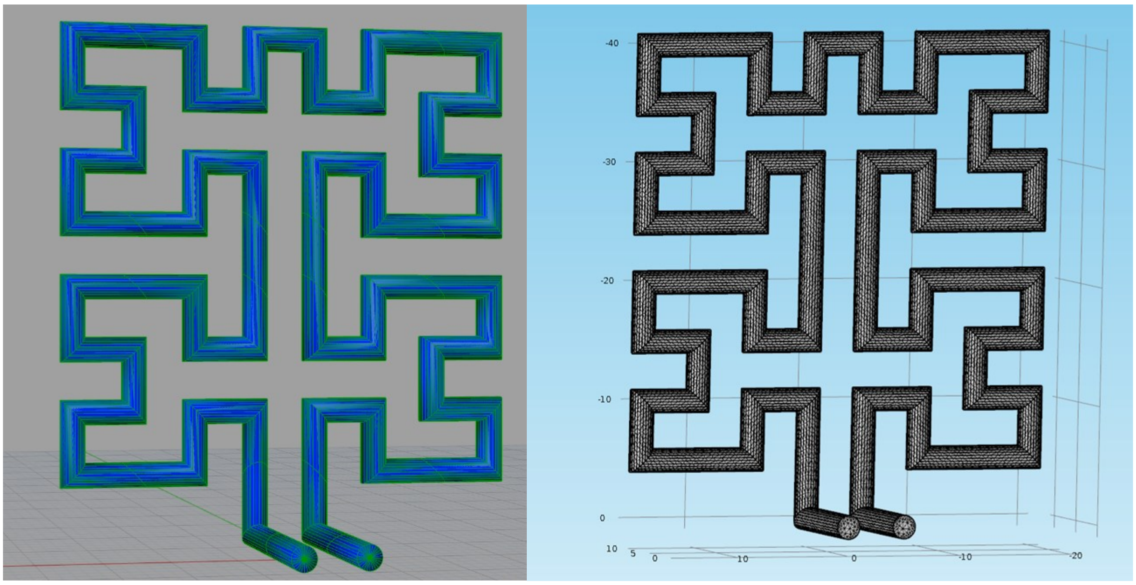


**Figure S1. Geometry in Rhinoceros environment (left) to be exported as stl file to COMSOL Multiphysics where is meshed as desired (left).**

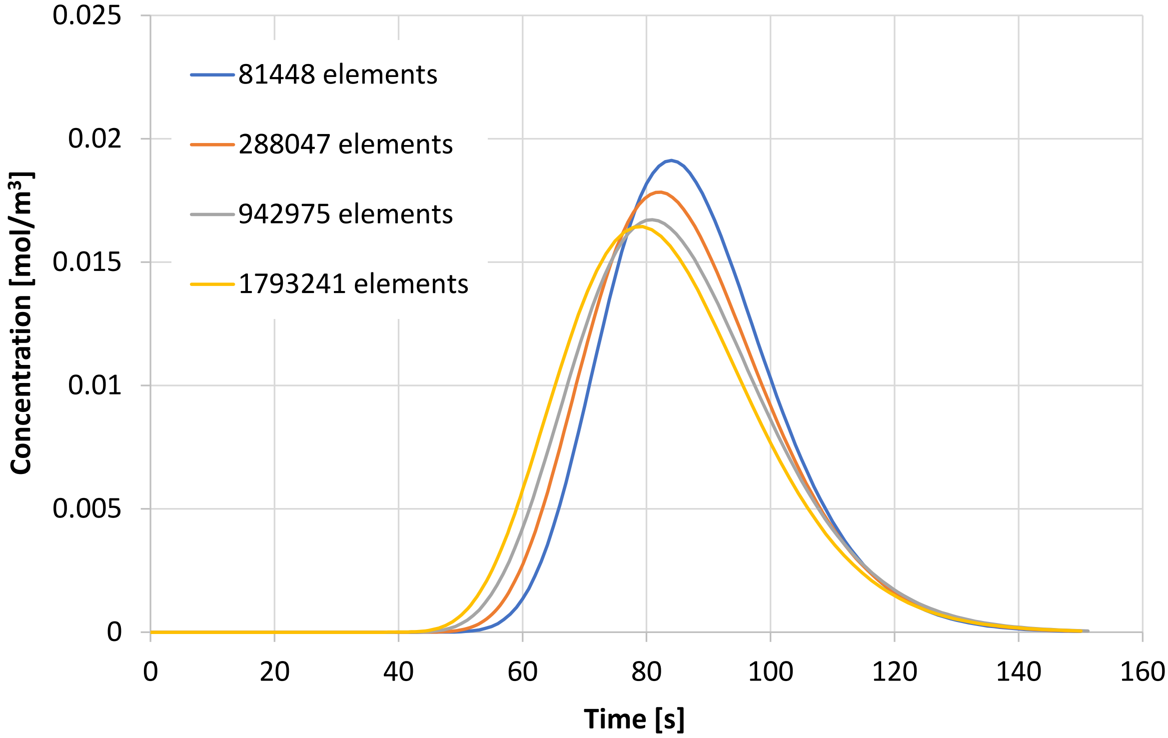
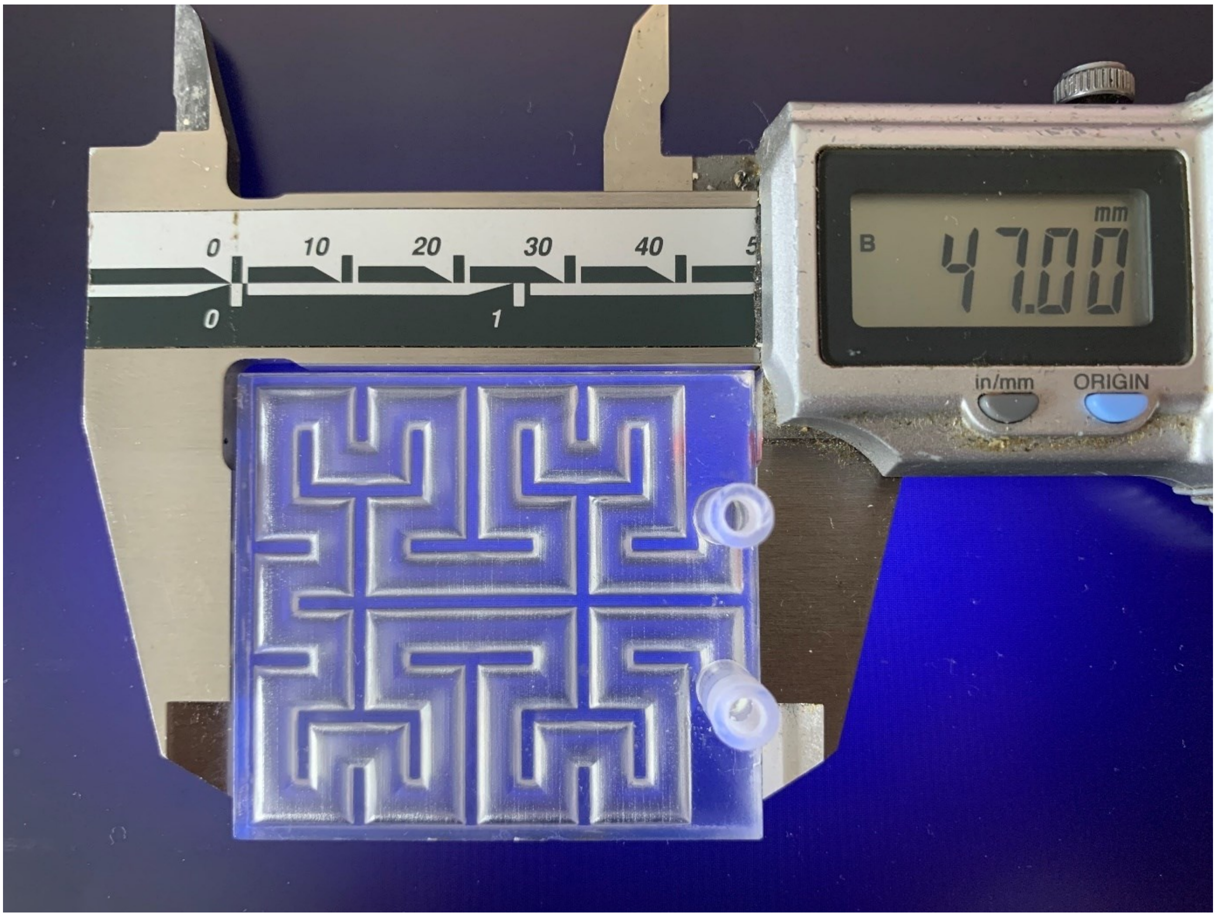
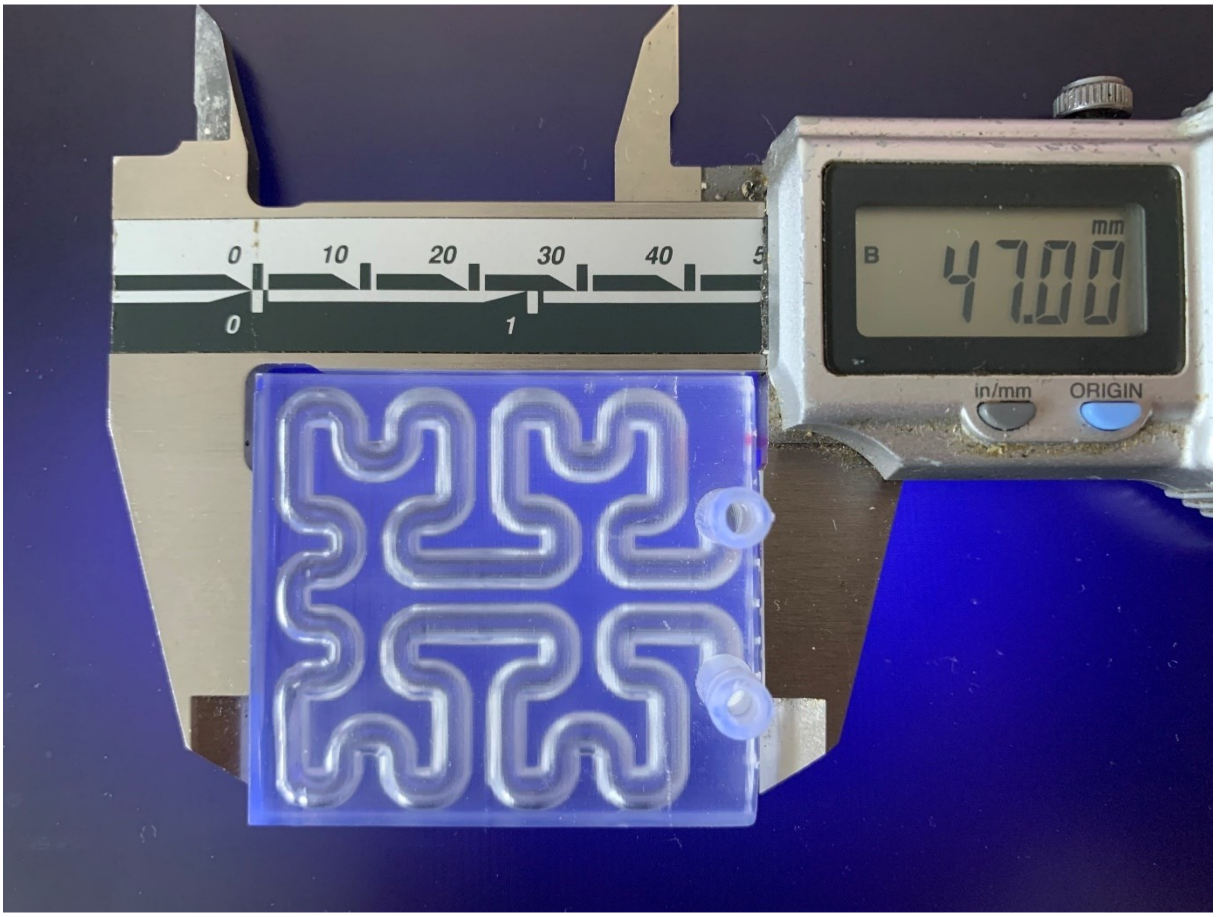



**Figure S2. Concentration at the outlet of the reactors simulated with a fixed carrier velocity of 0.01 m/s and different meshes for the same geometry.**

**Reactor architectural flexibility in 2D and in 3D**

The following are examples of fractal reactors that can be produced by 3D printing or with other methods (for the 2D examples). In this work we have used a Form 3 (from Formlabs, USA) and the reactors were produced with a transparent resin with a resolution of 50 micrometers in the *z*-axis.


0 10 20 30 40 5
0 1
mm
B 47.00
in/mm
ORIGIN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0 1
mm
B 47.00
in/mm
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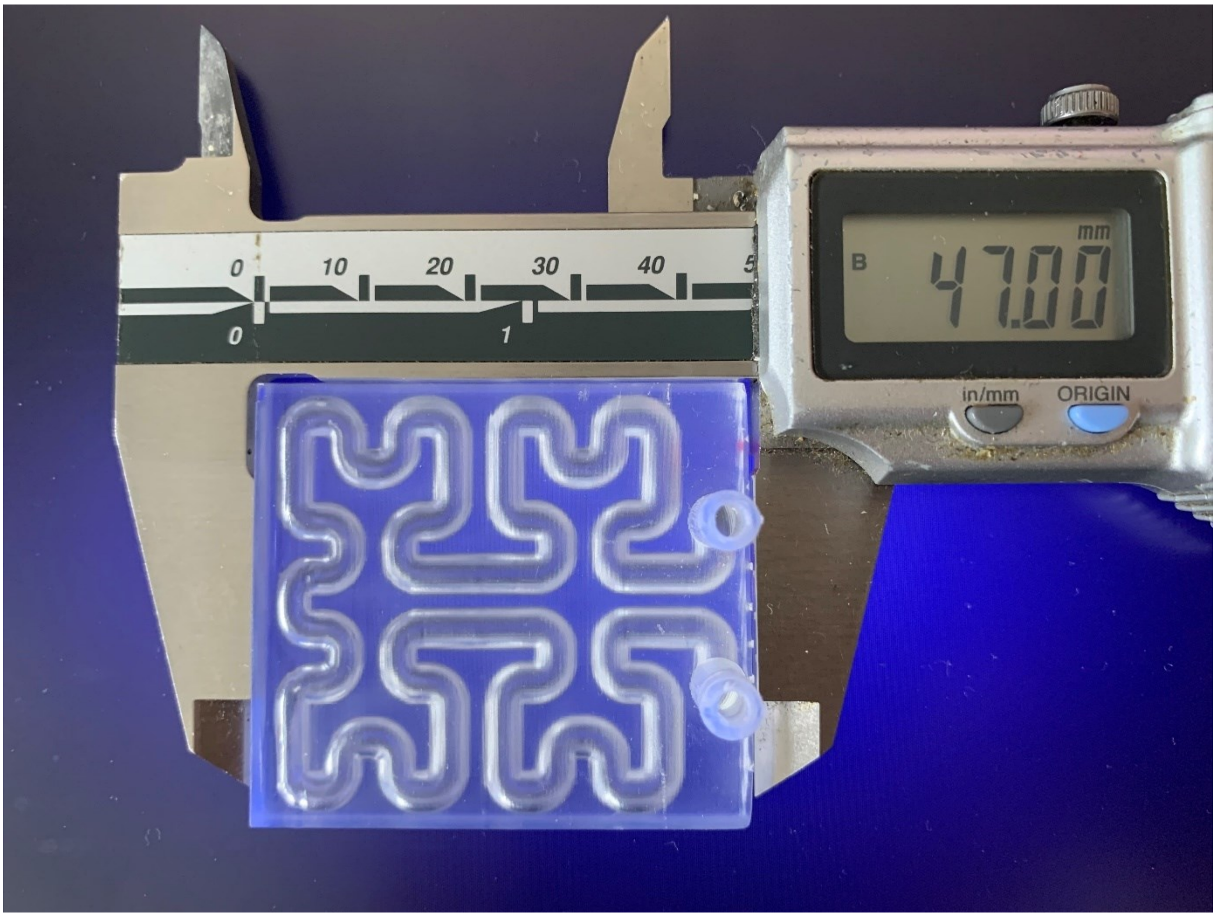
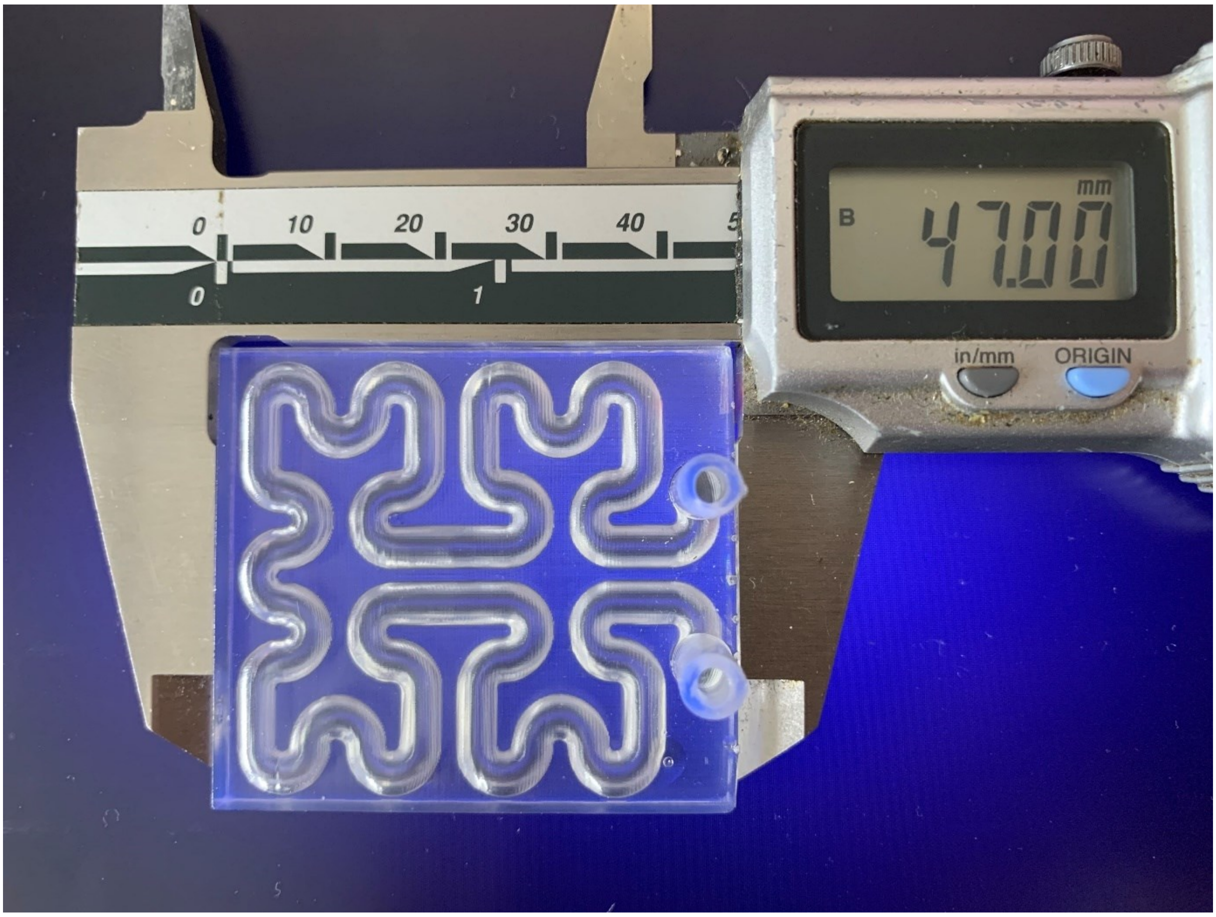
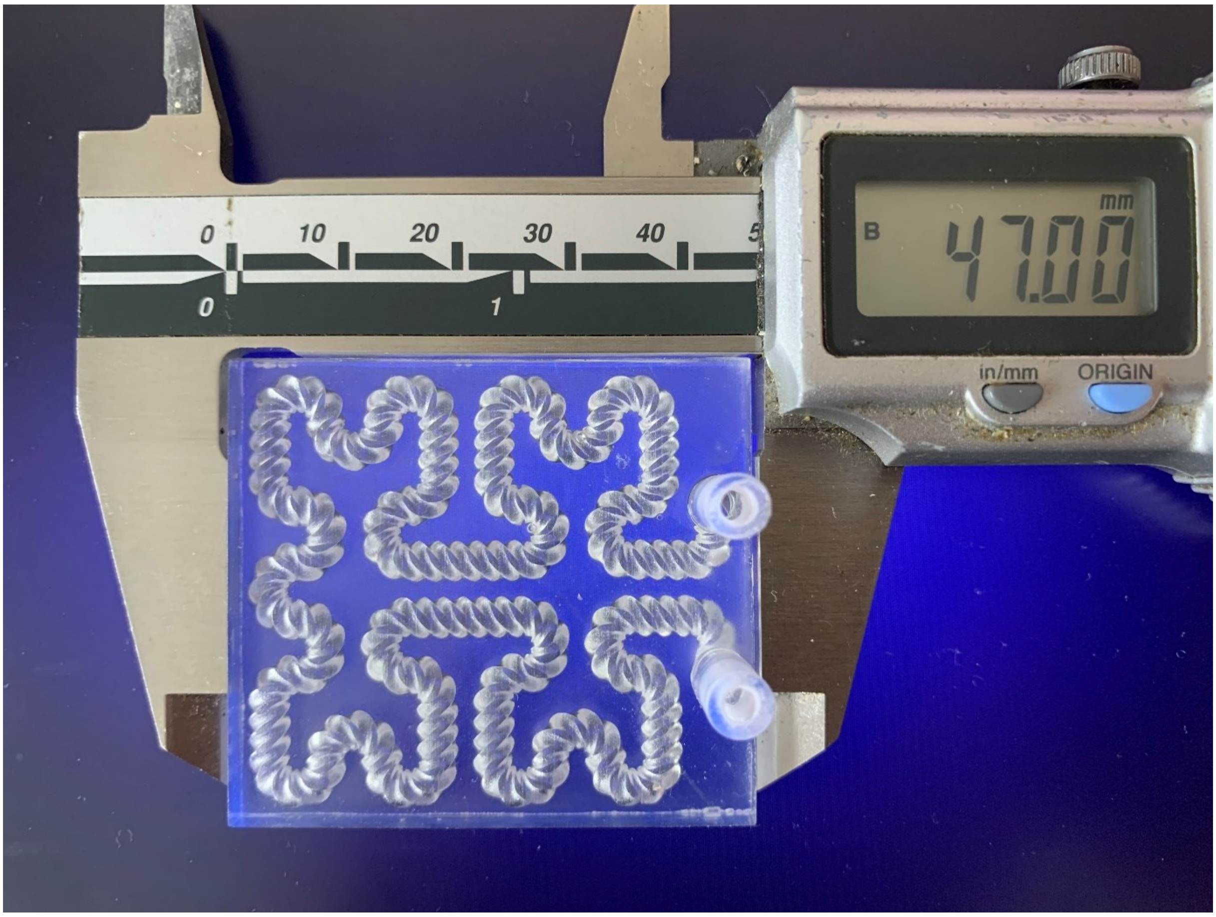
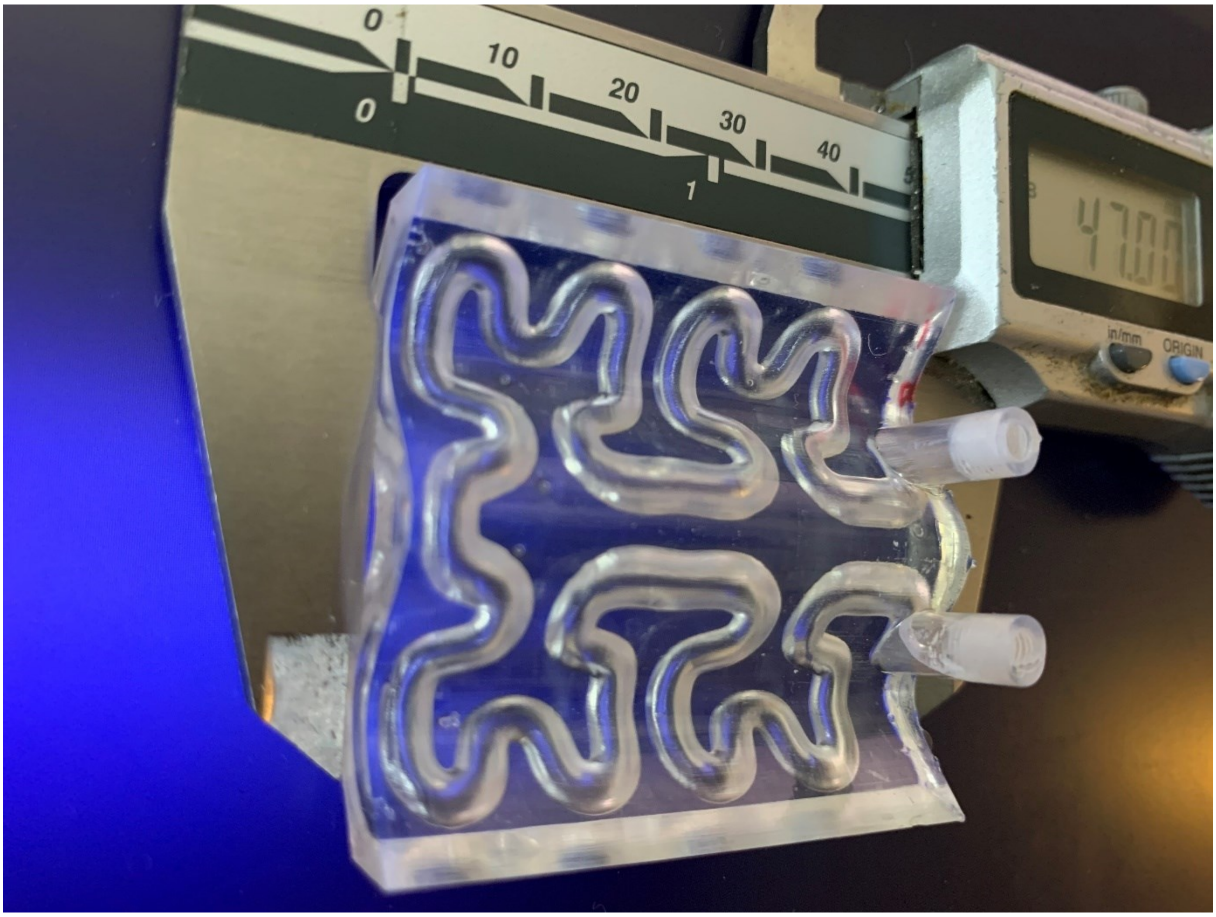
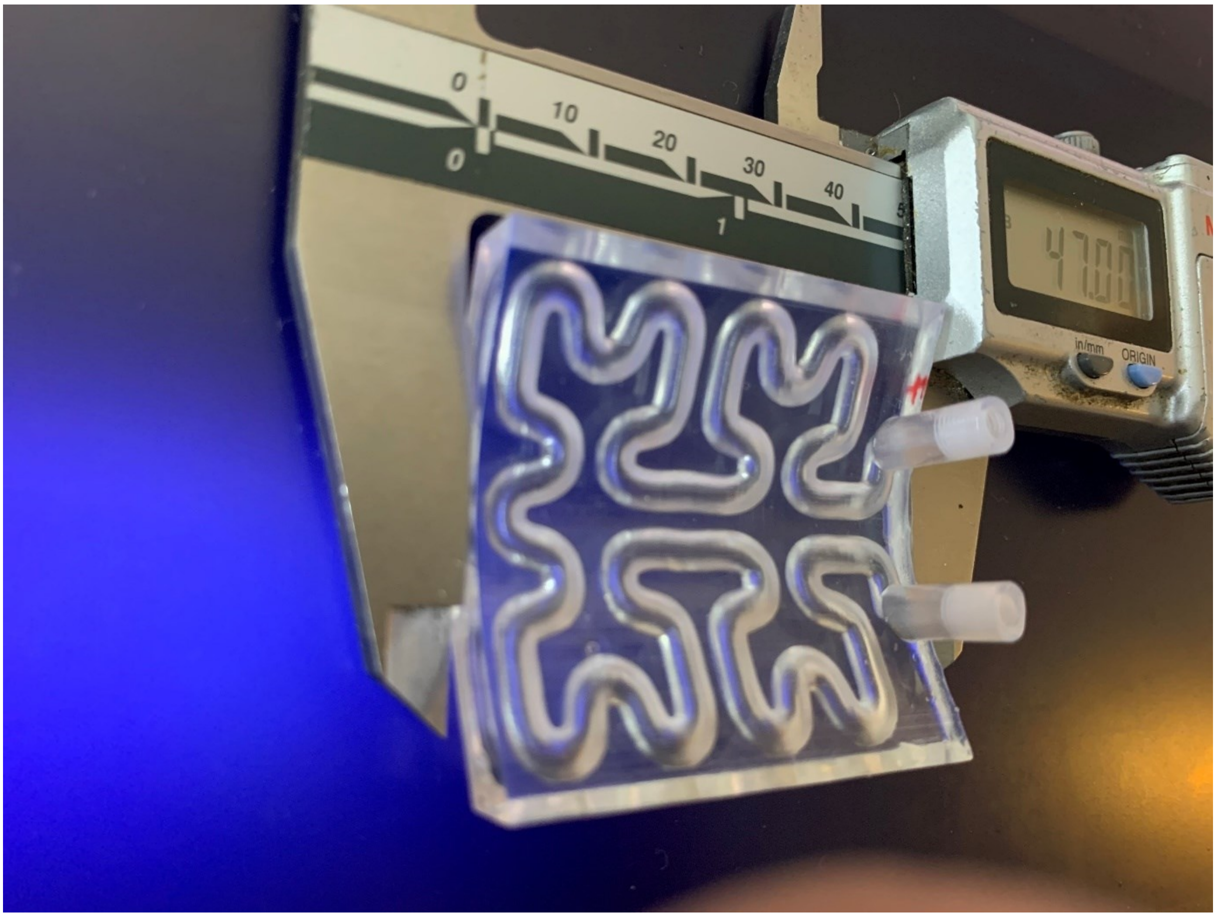
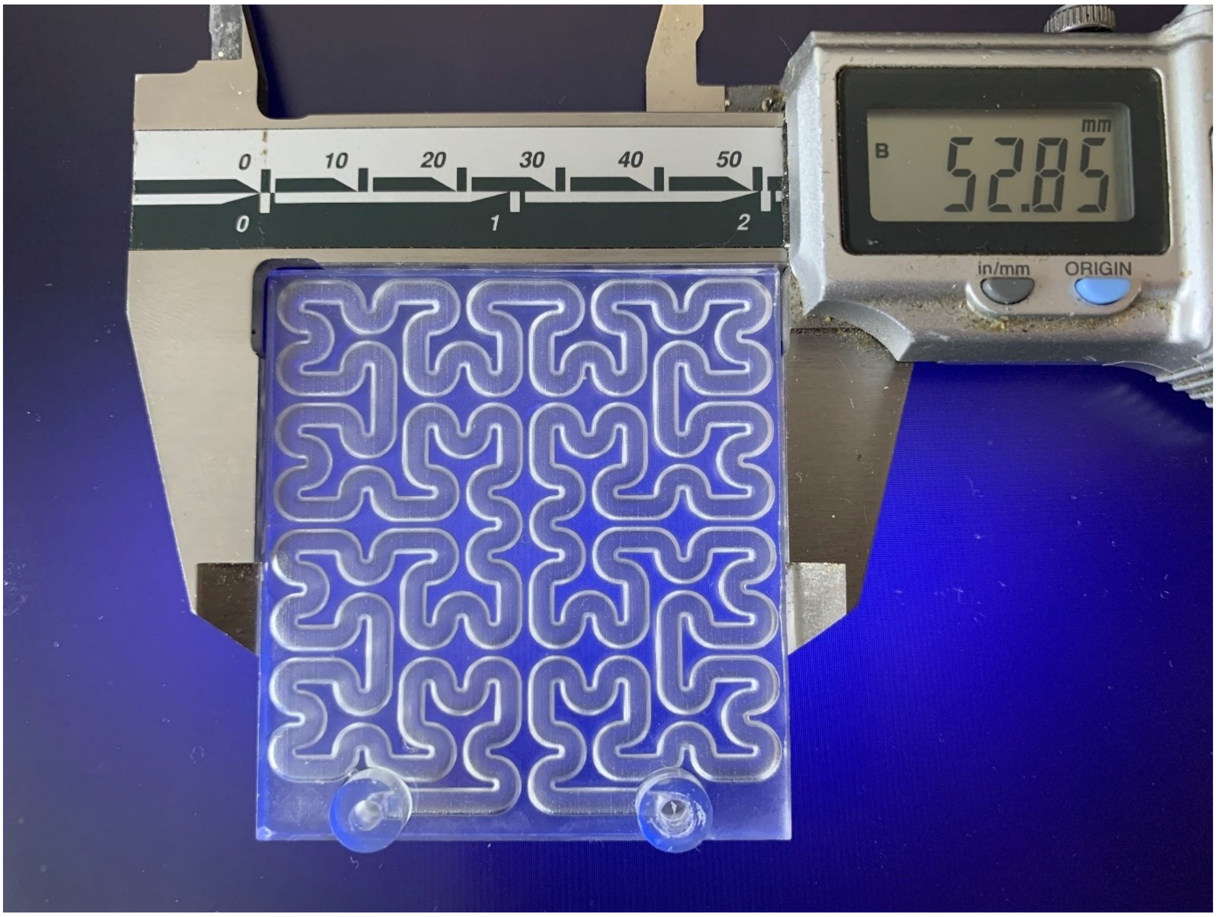

0
10
20
30
40
0
1
B
mm
47.00
in/mm
ORIGIN

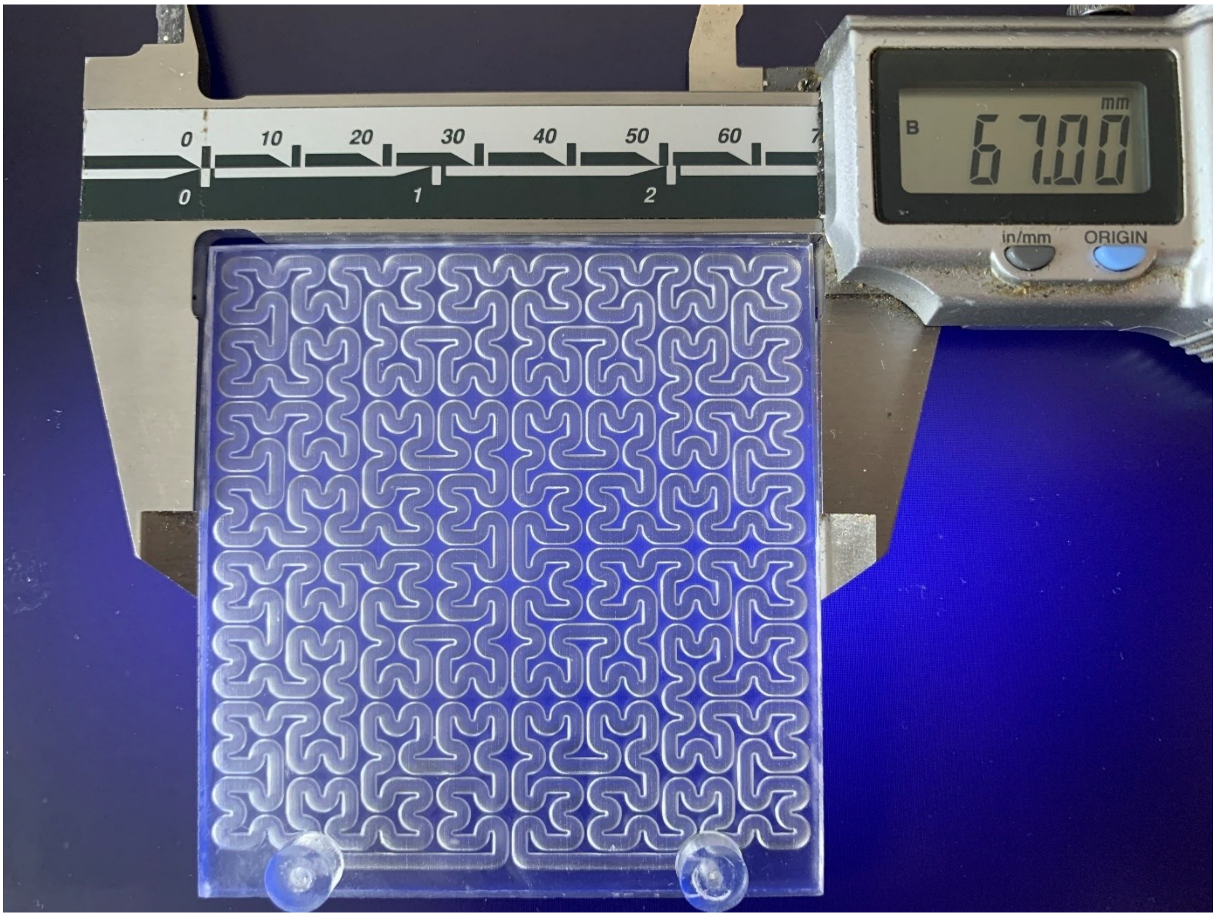

0
10
20
30
40
0
1
B
mm
47.00
in/mm
ORIGIN


0
10
20
30
40
0
1
mm
B
47.00
in/mm
ORIGIN

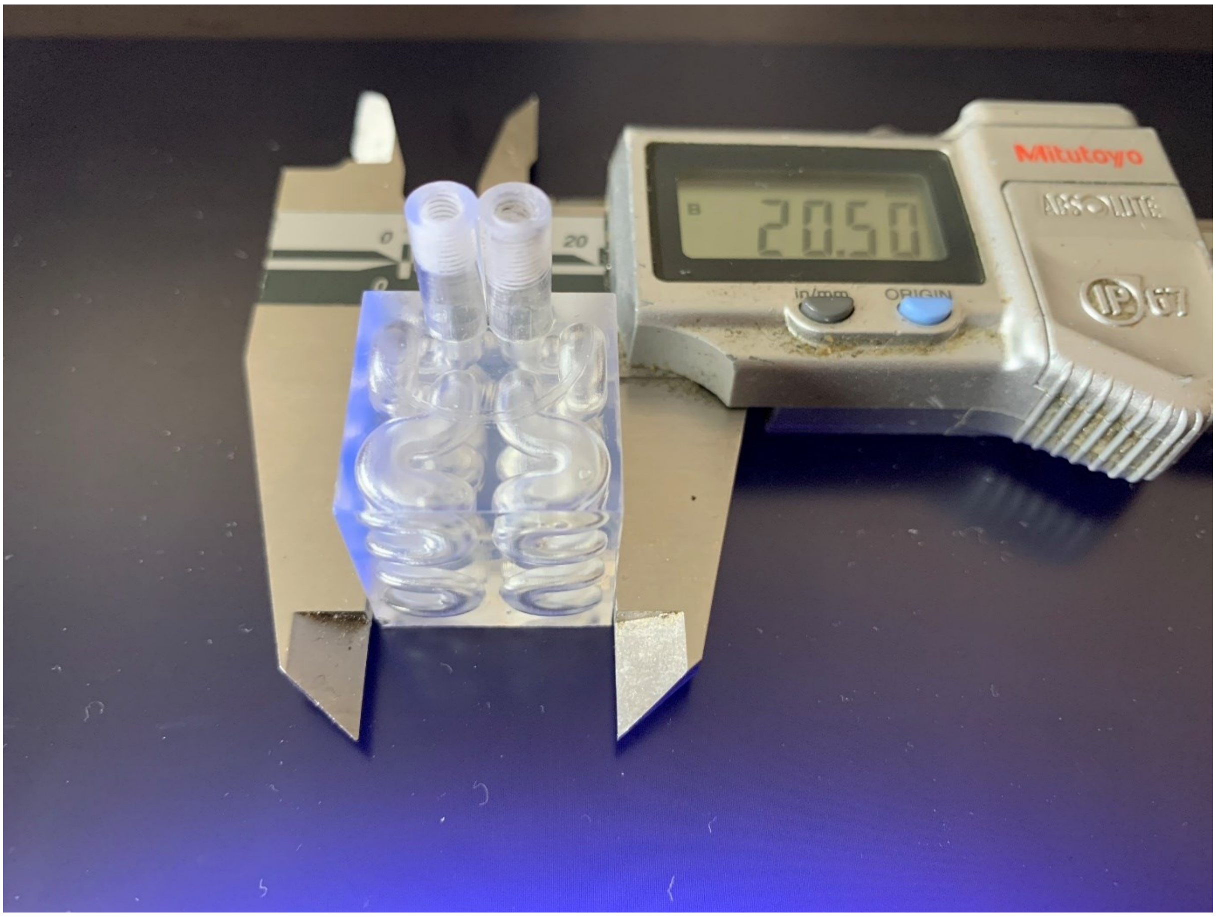

0
10
20
30
40
0
1
47.00
in/mm
ORIGIN


47.00
in/mm
ORIGIN

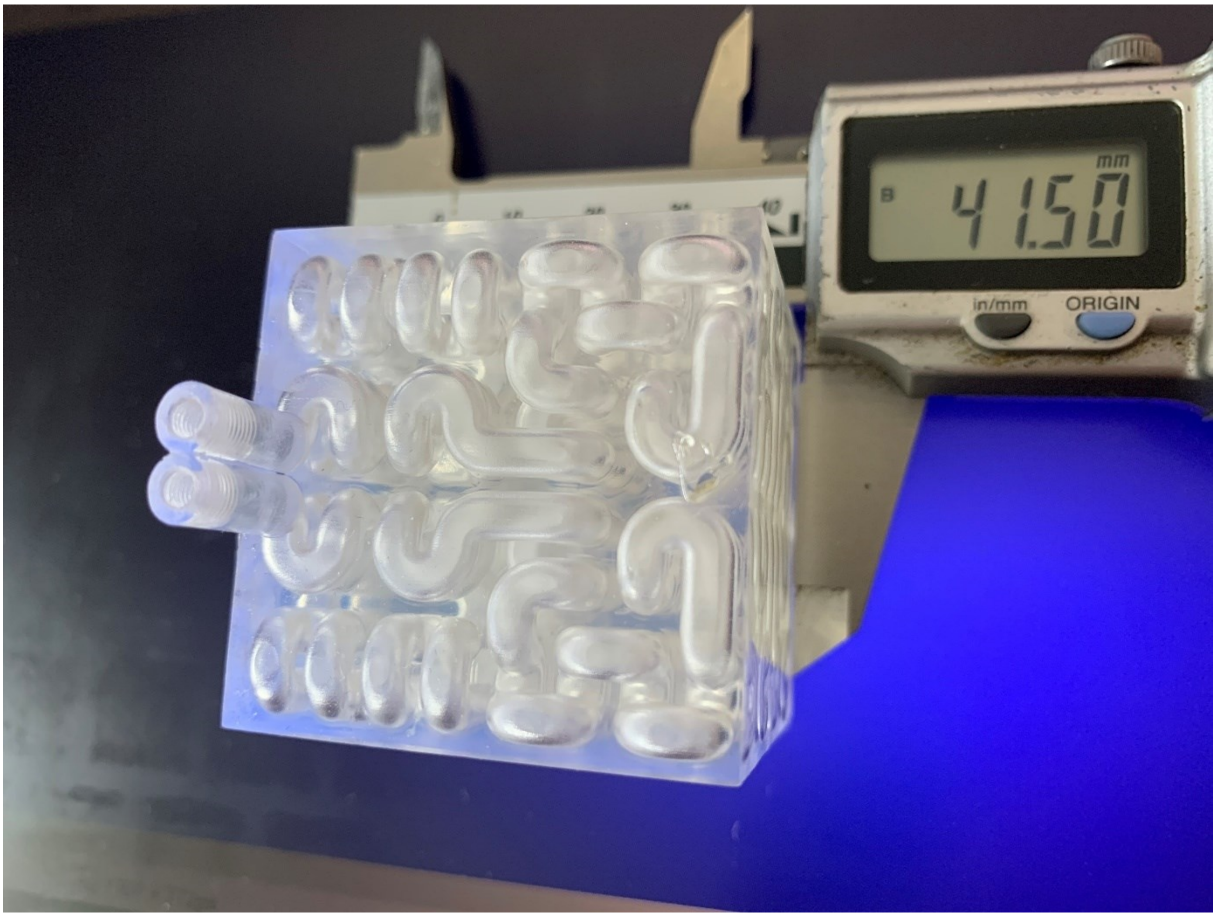

0
10
20
30
40
50
0
1
2
B
mm
52.85
in/mm
ORIGIN



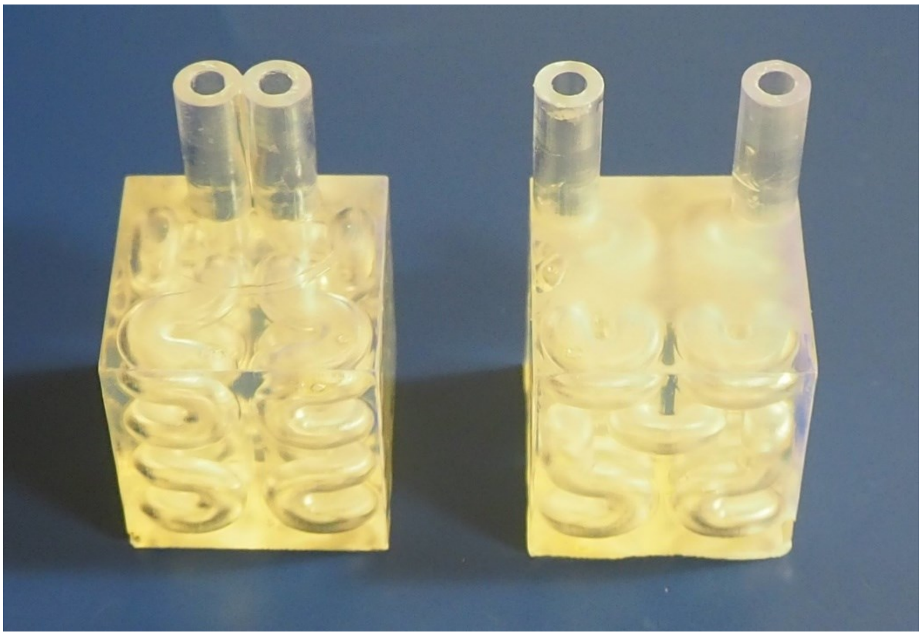
0 10 20 30 40 50 60
0 1 2
B
mm
67.00
in/mm
ORIGIN

Mitutoyo
ABSOLUTE
20.50
in/mm
ORIGIN

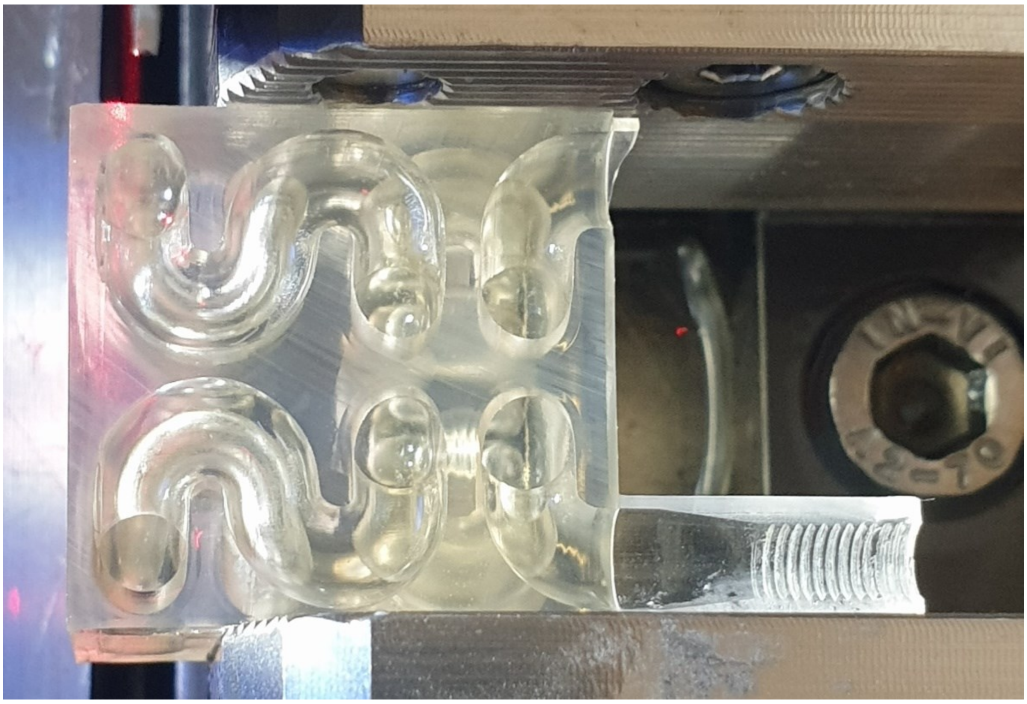


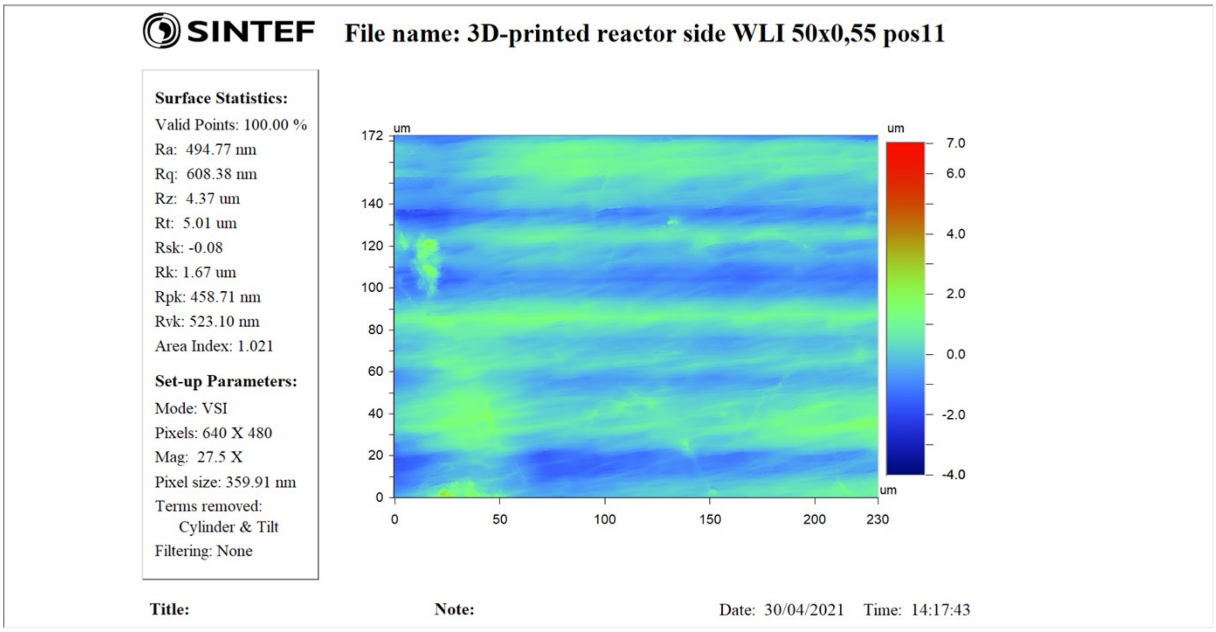
41.50
mm
in/mm
ORIGIN


**Internal rugosity of 3D printed reactors using stereolithography**

The reactor produced with the second iteration of the Hilbert curve in 3D was cutted and the surface observed with white light interferometry to determine the rugosity of the internal walls produced. Two pictures are shown here. The first one taken in the deepest area of the reactor tube where the layer-by-layer manufacturing of the reactor can be seen in detail. A larger mapping of the internal tubing was also done, but in this case, the cylindrical geometry of the reactor does not allow a straightforward visualization. For this reason, a cylindrical fit was used for the topographic visualization to reduce the effect of the curvature. As shown from these images, the internal walls of the reactor are very smooth.

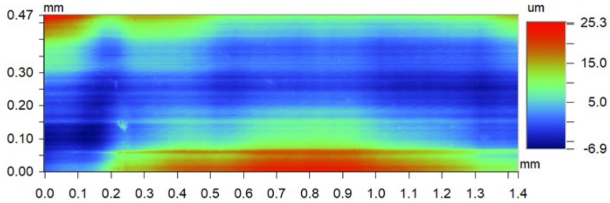




SINTEF **File name: 3D-printed reactor side WLI 50x0,55 stitch**

**Surface Statistics:**
Valid Points: 100.00 %
Ra: 4.79 um
Rq: 6.07 um
Rz: 31.79 um
Rt: 32.26 um
Rsk: 0.98
Rk: 12.17 um
Rpk: 10.99 um
Rvk: 2.05 um
Area Index: 1.031

**Set-up Parameters:**
Mode: VSI
Pixels: 3976 X 1315
Mag: 27.5 X
Pixel size: 359.91 nm
Terms removed:
Tilt
Filtering: None




**Title: Stitched File** **Note:** Date: 30/04/2021 Time: 16:26:38