

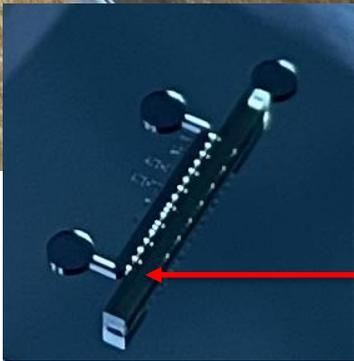
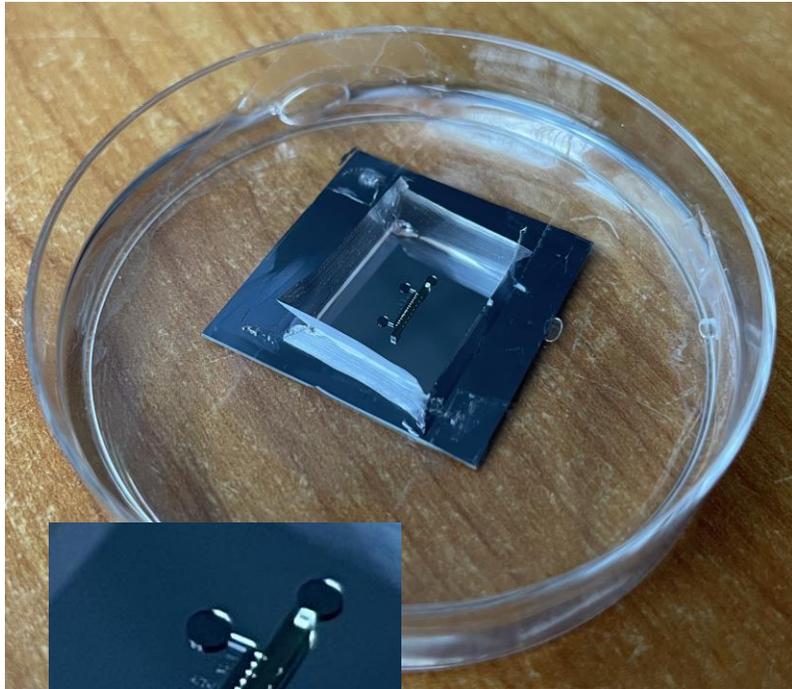
Lithographie laser bi-photons pour l'impression de moules PDMS dédiés à des applications micro-fluidique

Tiphaine MATEO – Morgan DELARUE: Equipe MILE (Micro-Nanofluidique pour les sciences de la vie et de l'environnement)

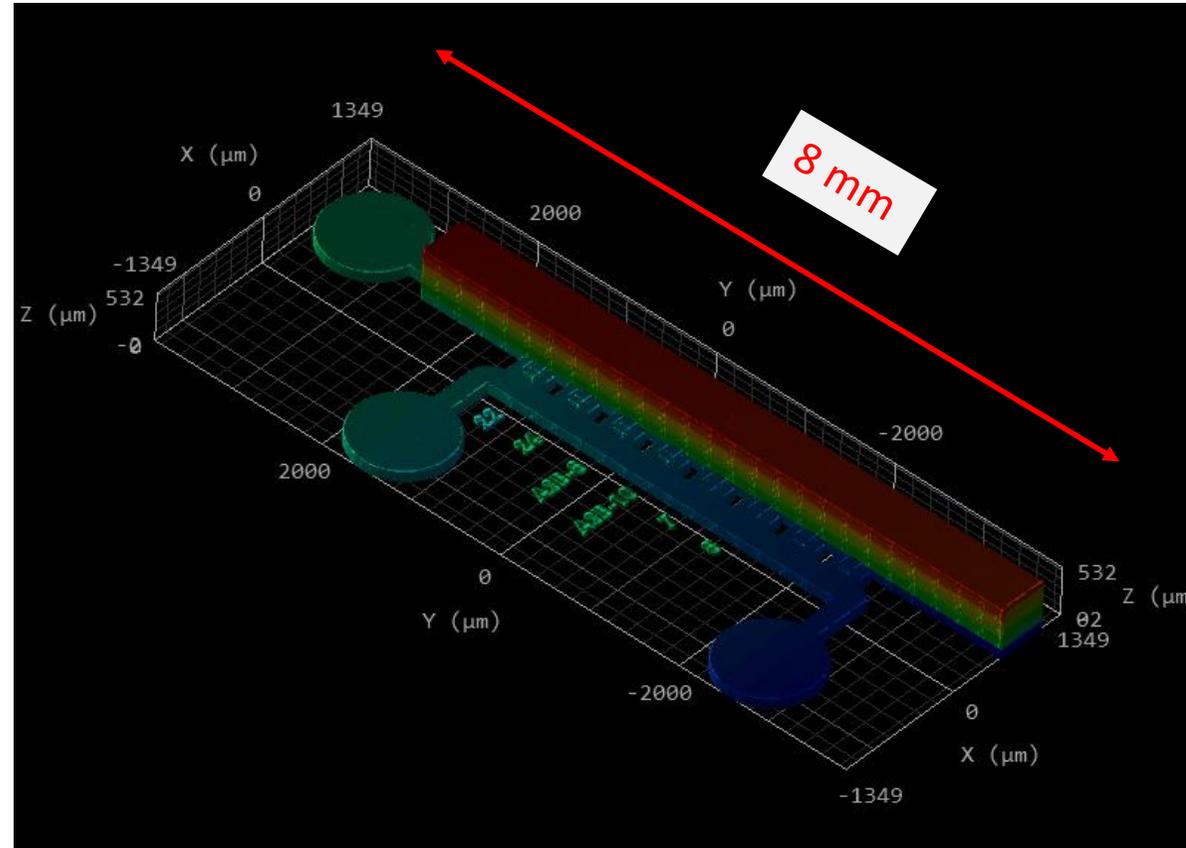
Fabien MESNILGRETE – PF CALMON: Service TEAM (Techniques et Equipements Appliqués aux Micro et nanotechnologies)

Moules PDMS par Litho Laser 3D

> Objectif: Fabrication de puces micro-fluidique

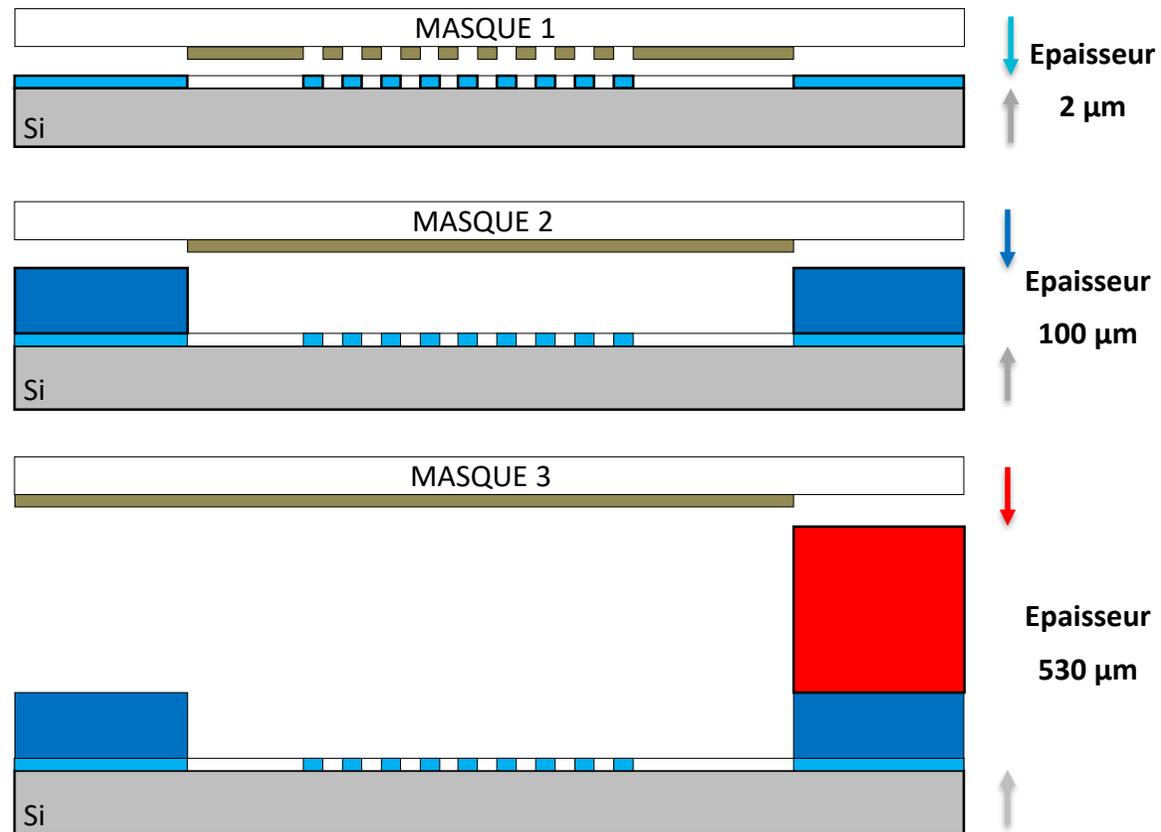
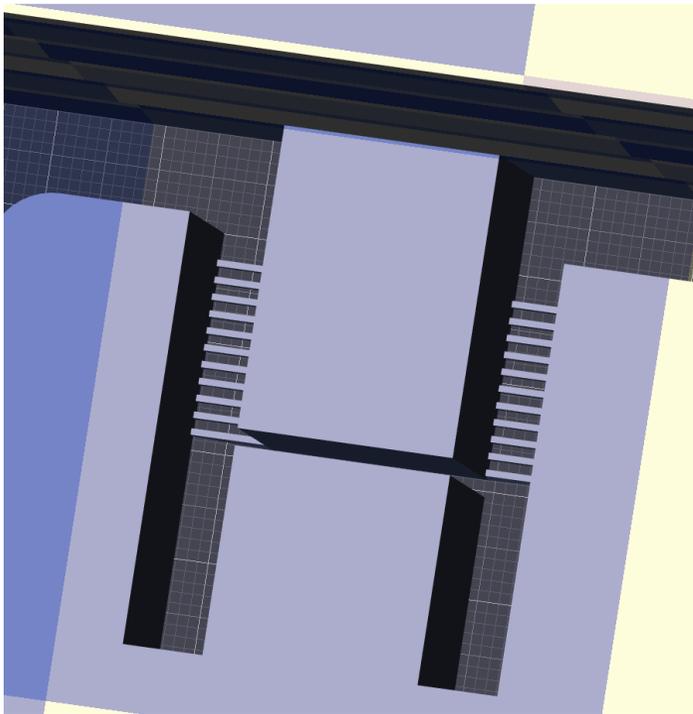


Résine IP-S
Dureté > 200 MPa



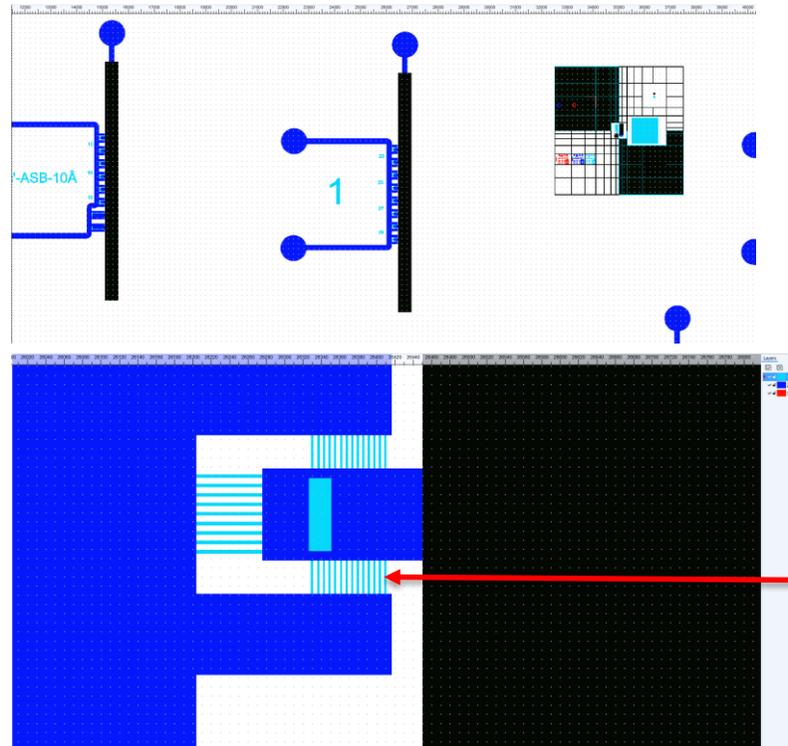
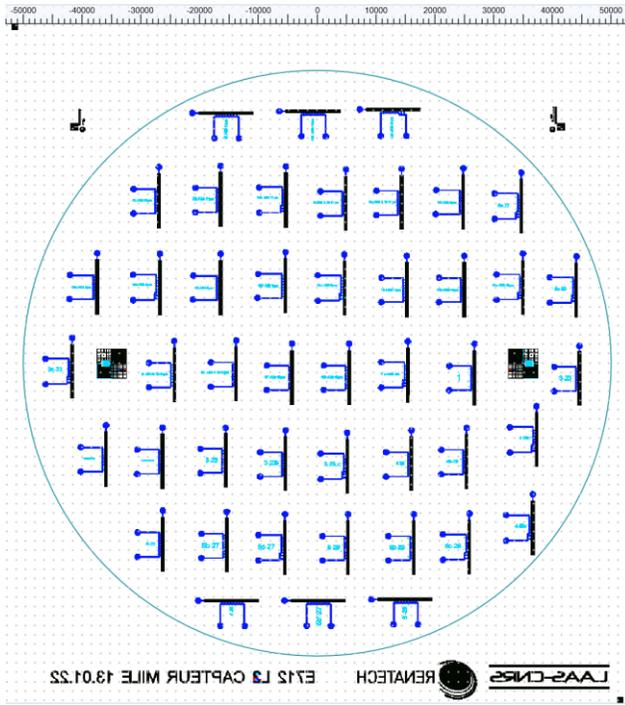
Moules PDMS par Litho Laser 3D

- > Procédés de lithographie optique – 3 niveaux de masques
- > Période de 2 ans – Une partie techno de travaux de thèse



Moules PDMS par Litho Laser 3D

- > Procédés avec des films DF, des films Suex et de la résine SU8: problèmes d'alignement et de respect des côtes.



Lignes 2 μm

Moules PDMS par Litho Laser 3D

- > Nanoscribe PP GT+ – Résine IP-S
- > Résolution 3D MF DiLL – Objectif x25
- > Novembre – Décembre 2022

The screenshot shows the DeScribe 2.7 interface with a 3D model of a mold. The model is a rectangular block with a central channel and two circular features. The axes are labeled X (μm), Y (μm), and Z (μm). The Z-axis is vertical, and the X and Y axes are horizontal. The model is shown in a perspective view.

The left panel shows the file generation details:

```

1 % File generated by DeScribe 2.7
2 %
3 % Creation time
4 % 2022-12-13T16:43:31+01:00
5 %
6 % Source file
7 % Type: Mesh
8 % Path: C:\GWL\PF\Tiphaine\run 19\Moule-ej.STL
9 %
10 % Volume
11 % 2.112 mm³
12 %
13 % Bounding box
14 % Minimum X: -1348.3 Y: -3873.124 Z: 0
15 % Maximum X: 1348.3 Y: 3873.124 Z: 530
16 %
17 % Transformation
18 % Scaling X: 1000 Y: 1000 Z: 1000
19 % Rotation X: 0 Y: 0 Z: 0 W: 1
20 % Translation X: -1348.3 Y: -9505.615 Z: 0
21 %
22 % Slicing
23 % SlicingMode: Fixed
24 % Distance: 1
25 % SimplificationTolerance: 0.05
26 % FixSelfIntersections: on
27 %
28 % Shell
29 % HatchingDistance: 0.5
30 % ContourCount: 12
31 % BaseSliceCount: 2
32 % Angle: auto
33 % ConcaveCornerMode: Sharp
34 %
35 % Scaffold
36 % HatchingDistance: 0.5
37 % Type: Triangles
38 % WallSpacing: 20
39 % FloorSpacing: 20
40 % WallLineCount: 2
41 % FloorSliceCount: 2
42 % Offset X: 0 Y: 0 Z: 0
43 % Stagger: off
44 %
45 % Splitting
46 % Mode: Rectangular
47 % BlockSize X: 274 Y: 254 Z: 100
48 % Offset X: 50 Y: 121.5 Z: 0
49 % Shear: 5
50 % Overlap: XY: 2 Z: 1
51 % BlockWidth X: 284.836 Y: 264.836 Z: 101
52 % BlockOrder: Lexical
    
```

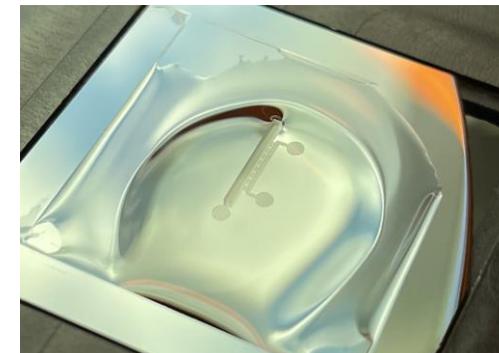
The right panel shows the scaling parameters:

Axis	Absolute (μm)	Relative
X	2696.6	1000
Y	7746.248	1000
Z	530	1000

The 'Lock aspect ratio' checkbox is checked.

The bottom right panel shows mesh statistics:

Mesh statistics
Number of triangles: 12372
Dimensions
X: 2696.6 μm
Y: 7746.248 μm
Z: 530 μm
Volume: 2.112 mm³



Dépôt d'une
goutte de résine

Pas de recuit

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> Slicing 1 μm

The screenshot shows the DeScribe 2.7 software interface. On the left, a code editor displays the STL file's metadata, with the 'Slicing' section highlighted in red:

```

22 % Slicing
23 % SlicingMode: Fixed
24 % Distance: 1
25 % SimplificationTolerance: 0.05
26 % FixSelfIntersections: on
  
```

The central 3D view shows a blue mold structure on a black grid. The right-hand 'Model' panel shows the 'Slicing' settings:

Axis	Absolute (μm)	Relative
X	2696.6	1000
Y	7746.248	1000
Z	530	1000

Below the slicing settings, the 'Mesh statistics' are displayed:

- Number of triangles: 12372
- Dimensions: X: 2696.6 μm , Y: 7746.248 μm , Z: 530 μm
- Volume: 2.112 mm^3

The bottom status bar shows 'Line 33, Column 29' and the system tray includes the date '2023-01-13' and time '09:53'.

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> Structure alvéolaire

The screenshot displays the DeScribe 2.7 software interface. The main window shows a 3D model of a honeycomb (alveolar) structure. The left sidebar contains a log window with the following text:

```

1 % File generated by DeScribe 2.7
2 %
3 % Creation time
4 % 2022-12-13T16:43:31+01:00
5 %
6 % Source file
7 % Type: Mesh
8 % Path: C:\GWL\PPFC\Tiphaine\run 19\Moule-ej.STL
9 %
10 % Volume
11 % 2.112 mm³
12 %
13 % Bounding box
14 % Minimum X: -1348.3 Y: -3873.124 Z: 0
15 % Maximum X: 1348.3 Y: 3873.124 Z: 530
16 %
17 % Transformation
18 % Scaling X: 1000 Y: 1000 Z: 1000
19 % Rotation X: 0 Y: 0 Z: 0 W: 1
20 % Translation X: -1348.3 Y: -9505.615 Z: 0
21 %
22 % Slicing
23 % SlicingMode: Fixed
24 % Distance: 1
25 % SimplificationTolerance: 0.05
26 % FixSelfIntersections: on
27 %
28 % Shell
29 % HatchingDistance: 0.5
30 % ContourCount: 12
31 % BaseSliceCount: 2
32 % Angle: auto
33 % ConcaveCornerMode: Sharp
34 %
35 % Scaffold
36 % HatchingDistance: 0.5
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43 % Stagger: off
44 %
45 % Splitting
46 % Mode: Rectangular
47 % BlockSize X: 274 Y: 254 Z: 100
48 % Offset X: 50 Y: 121.5 Z: 0
49 % Shear: 5
50 % Overlap: XY: 2 Z: 1
51 % BlockWidth X: 284.836 Y: 264.836 Z: 101
52 % BlockOrder: Lexical
    
```

The right sidebar shows the 'Scaffold' settings panel:

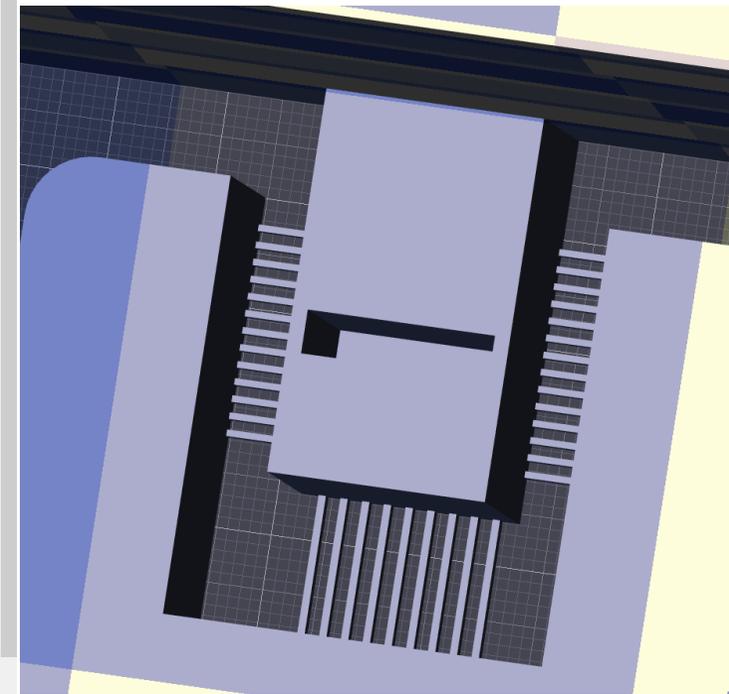
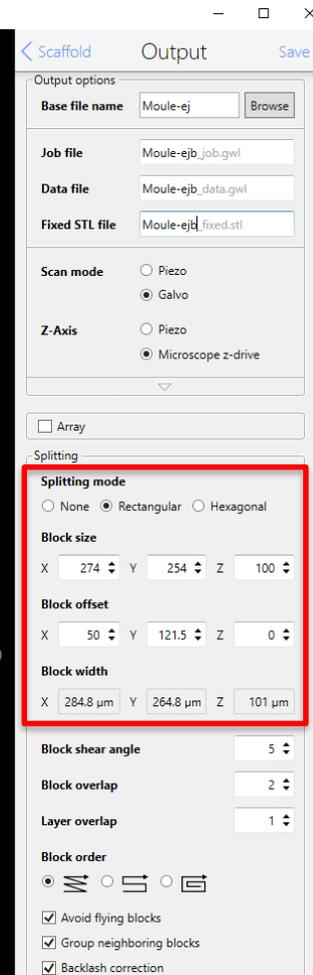
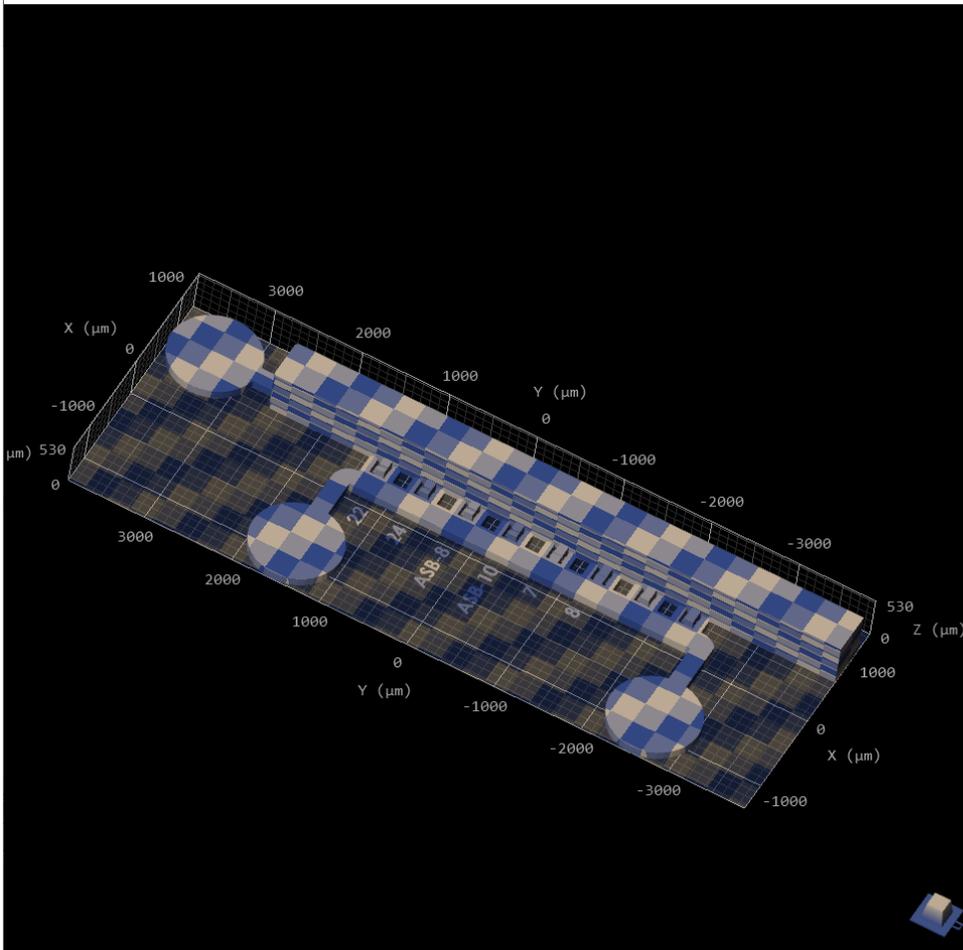
- Scaffold parameters:** Hatching distance: 0.5
- Scaffold type:** Triangles (selected), Tetrahedron, Planes, Hollow
- Scaffolding:** Spacing: Walls (vertical) 20, Floors (horizontal) 20; Thickness: Walls (vertical) 2, Floors (horizontal) 2
- Scaffold offset:** X: 0, Y: 0, Z: 0
- Secondary scaffold walls
- Stagger scaffold walls
- Generate scaffold** button
- Display options:** Clipping: Axis X, Y, Z (Z selected); Offset: [Slider]; Show scaffold; Show mesh overlay; Disable preview; Disable default calculations
- Options** button

The bottom status bar shows 'Line 33, Column 29' and the system tray with the date '2023-01-13' and time '10:04'.

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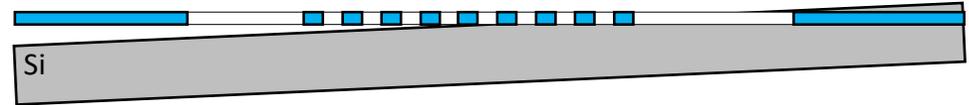
> Raccordements de champs

Import STL - C:\GWL\PFC\Tiphaine\run 19\Moule-ej.STL



Moules PDMS par Litho Laser 3D

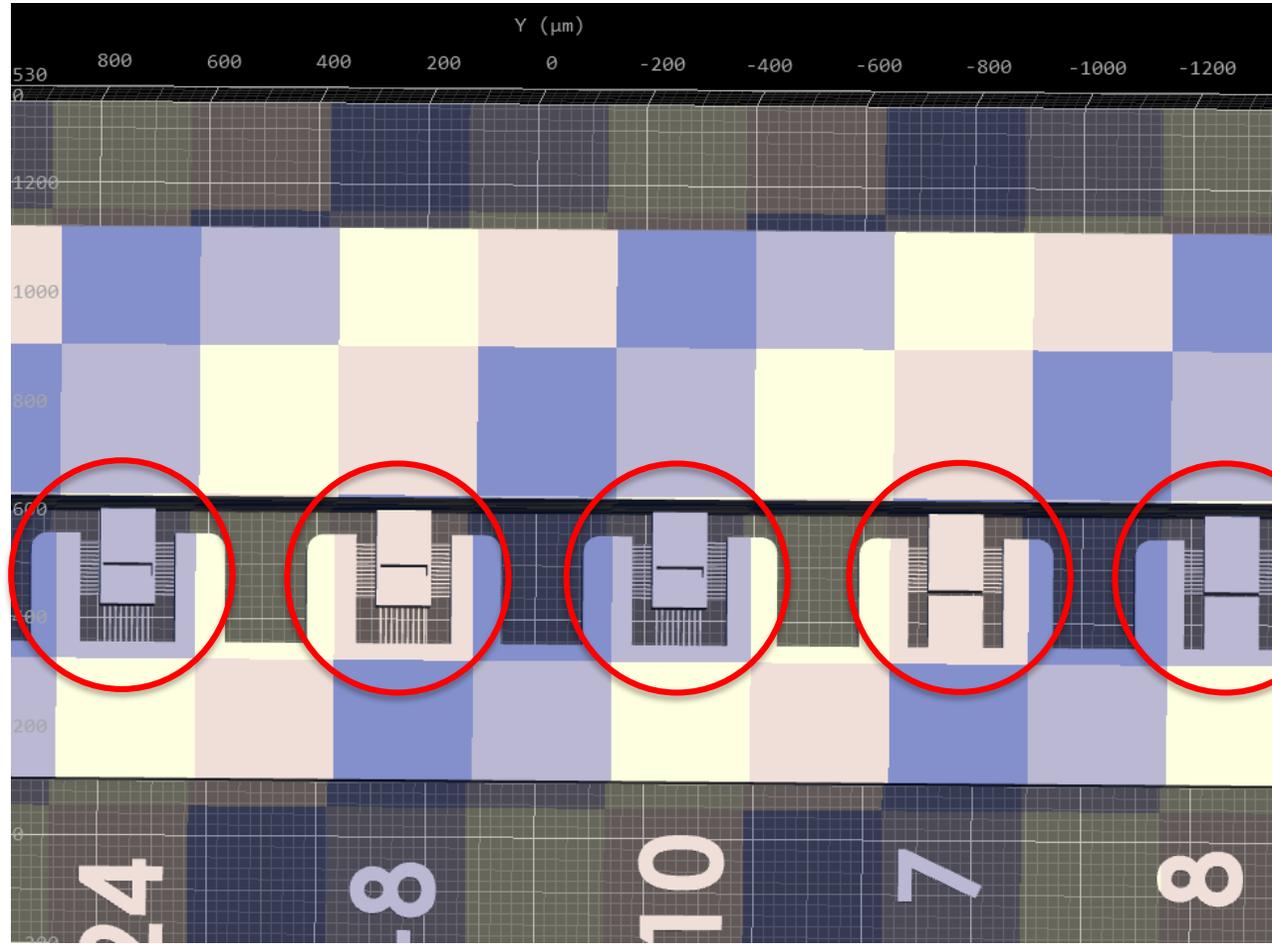
> Correction de planéité



```

Moule-em_data.gwl* - DeScribe 2.7
File Edit 3D Preview Debug Window Help
Moule-em_data.gwl* x
91
92 MoveStageX -598
93 MoveStageY 254
94 MoveStageX 50
95
96 AddZDrivePosition -100
97
98 % BLOCK 7/1/0
99 include Moule-em_files\Moule-em_7_1_0.gwlb
100
101 MoveStageX 274
102
103 FindInterfaceAt SinterfacePos ←
104
105 % BLOCK 8/1/0
106 include Moule-em_files\Moule-em_8_1_0.gwlb
107
108 MoveStageX 274
109
110 AddZDrivePosition -100
111
112 % BLOCK 9/1/0
113 include Moule-em_files\Moule-em_9_1_0.gwlb
114
115 MoveStageX -598
116 MoveStageY 254
117 MoveStageX 50
118
119 AddZDrivePosition -100
120
121 % BLOCK 7/2/0
122 include Moule-em_files\Moule-em_7_2_0.gwlb
123
124 MoveStageX 274
125
126 FindInterfaceAt SinterfacePos ←
127
128 % BLOCK 8/2/0
129 include Moule-em_files\Moule-em_8_2_0.gwlb
130
131 MoveStageX 274
132
133 AddZDrivePosition -100
134
135 % BLOCK 9/2/0
136 include Moule-em_files\Moule-em_9_2_0.gwlb
137
138 MoveStageX -2242
139 MoveStageY 254
140 MoveStageX 50
141
142 AddZDrivePosition -100
  
```

Détection
Interface
Si - Résine



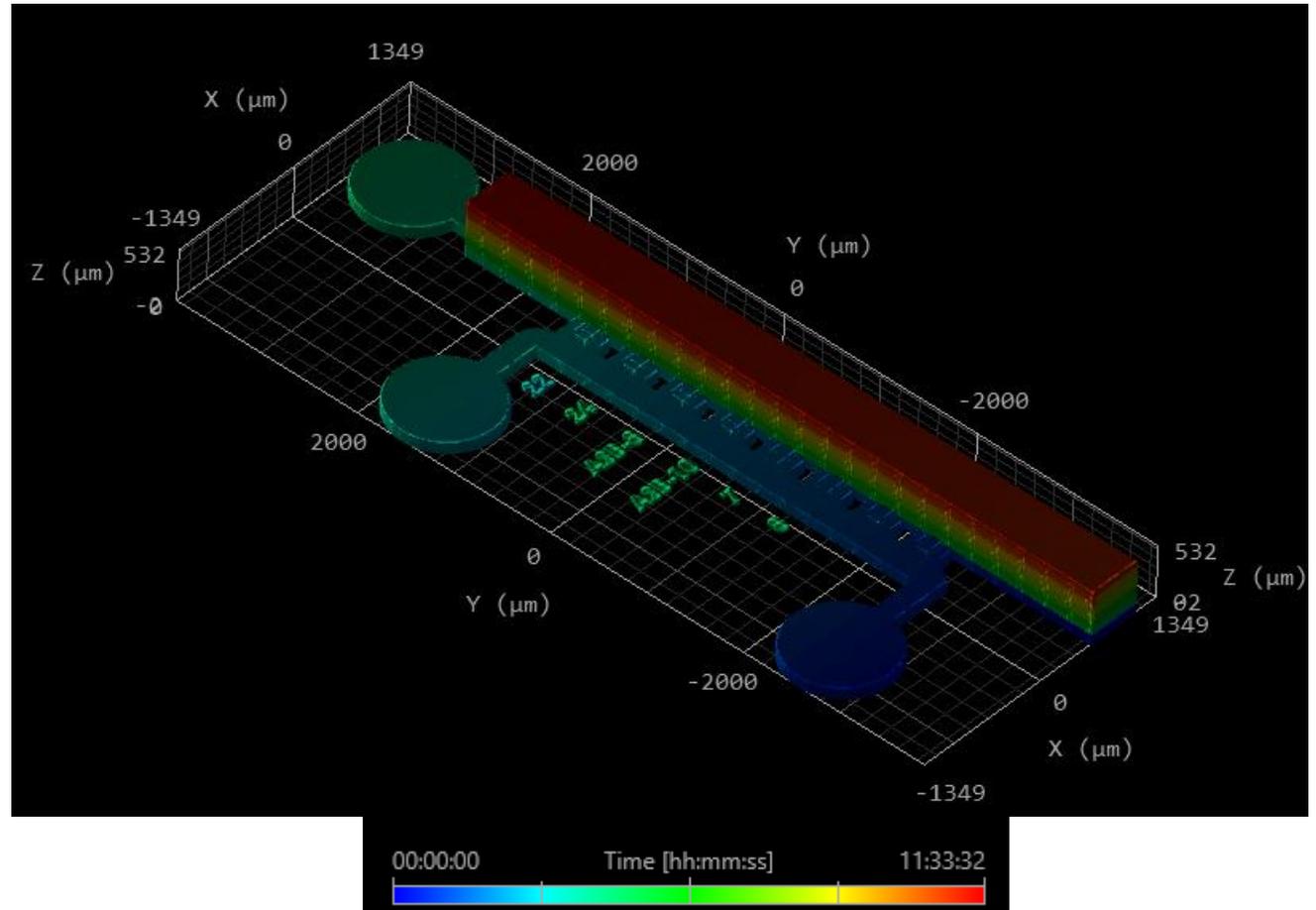
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> Paramètres d'écriture

Moule-ej_job.gwl - DeScribe 2.7
File Edit 3D Preview Debug Window Help

```

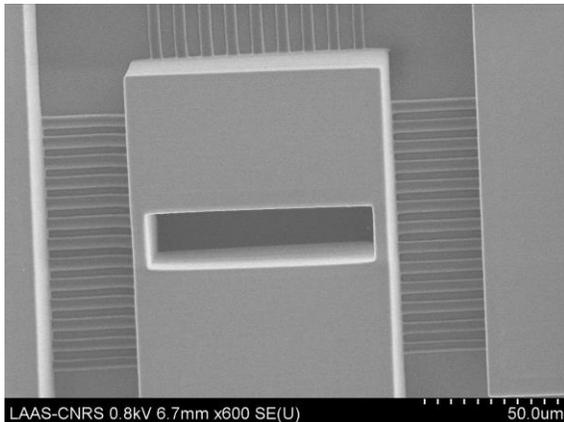
1 % File generated by DeScribe 2.7
2
3 % System initialization
4 InvertZAxis 1
5
6 % Writing configuration
7 GalvoScanMode
8 ContinuousMode
9 PiezoSettlingTime 10
10 GalvoAcceleration 10
11 StageVelocity 200
12
13 % Scan field offsets
14 XOffset 0
15 YOffset 0
16 ZOffset 0
17
18 % Writing parameters
19 PowerScaling 1.0
20
21 % Shell writing parameters
22 var $shellLaserPower = 80
23 var $shellScanSpeed = 40000
24
25 % Scaffold writing parameters
26 var $scaffoldLaserPower = 80
27 var $scaffoldScanSpeed = 40000
28
29 % Base writing parameters
30 var $baseLaserPower = $shellLaserPower
31 var $baseScanSpeed = 20000
32
33 var $interfacePos = 0.5
34
35 % Include slicer output
36 include Moule-ej_data.gwl
37
38
  
```



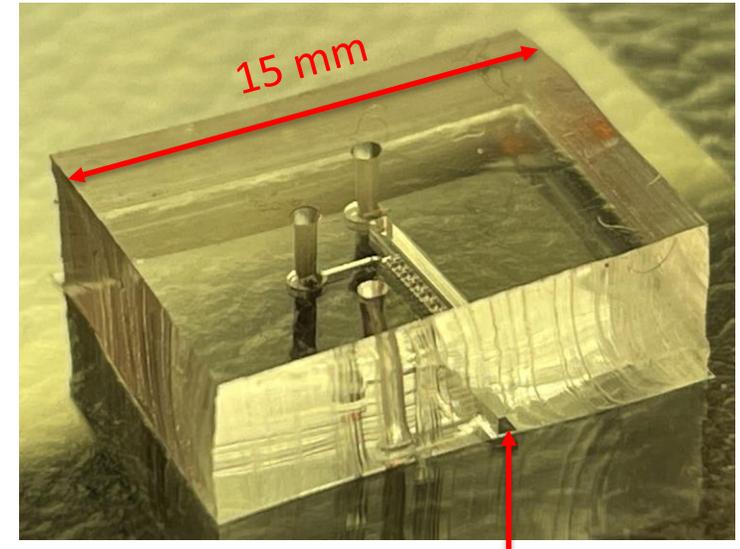
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> Avantages

- Alignement des couches
- Répétabilité des dimensions ($h=530 \mu\text{m} \pm 3 \mu\text{m}$)
- Changement des dimensions
- Réplication de contre-moules en PDMS



Puce micro-fluidique en PDMS



Ouverture section carrée

> Inconvénients

- Perte fabrication collective sur wafer
- Durée d'écriture de 10h

Moules PDMS par Litho Laser 3D

Merci pour votre attention

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