Ultra-high-resolution 3D-printing for biomedical applications

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High-precision 3D-printing

- Customers needs:
  - Manufacture micro-parts with sub-micron resolution
  - Application in microfluidics, Medical-Device, cellular biology & tissue-engineering, micro-robotics
- Our solution:
  - Laser 3D-printing in polymers and biological materials.

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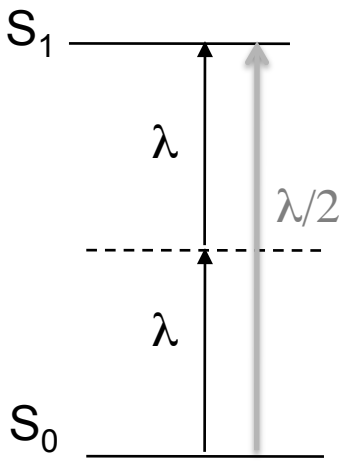
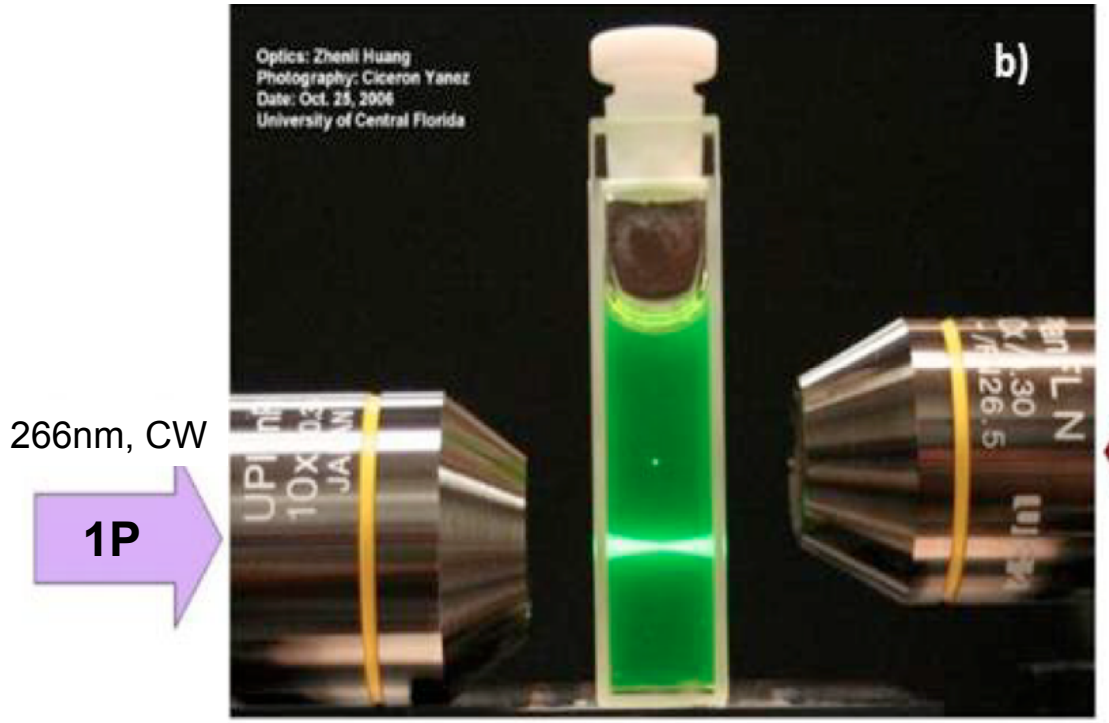
How can we print with sub-micron resolution ?

- The Two-Photon-Absorption Technology
  - Polymerisation or Molecular cross linking process
  - Polymerisation occurs only within the focal-point of the laser





$$\text{Nonlinear absorption} = \alpha_1 + \alpha_2 I$$

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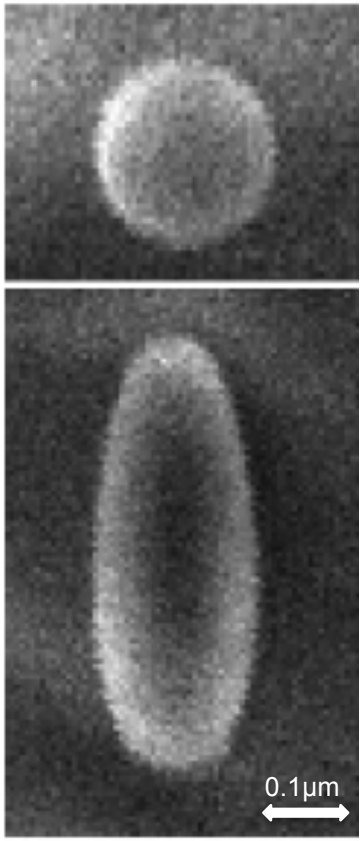
How small can we print ?

- Voxel size *(Voxel = 3D Pixel)*
  - 200 x 600nm in our standard system
  - Depends on laser wavelength
  - Depends on material photo-chemical reaction
  - Can be as small as 75nm in diameter
- Adjustable voxel size
  - Adjustable from 0.2 to 2µm
  - Adjustable resolution for faster printing
- **->** Direct laser writing with submicron resolution

SEM image of a single voxel



Lateral x-section: 0.2um

Vertical x-section: 0.6um

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Products

- Our offer: **a 3D-micro-printing system for research works**

- **µFAB-3D**
  - Standard System
  - Advanced System

Products

- Our offer: **a 3D-micro-printing system for prototyping works**

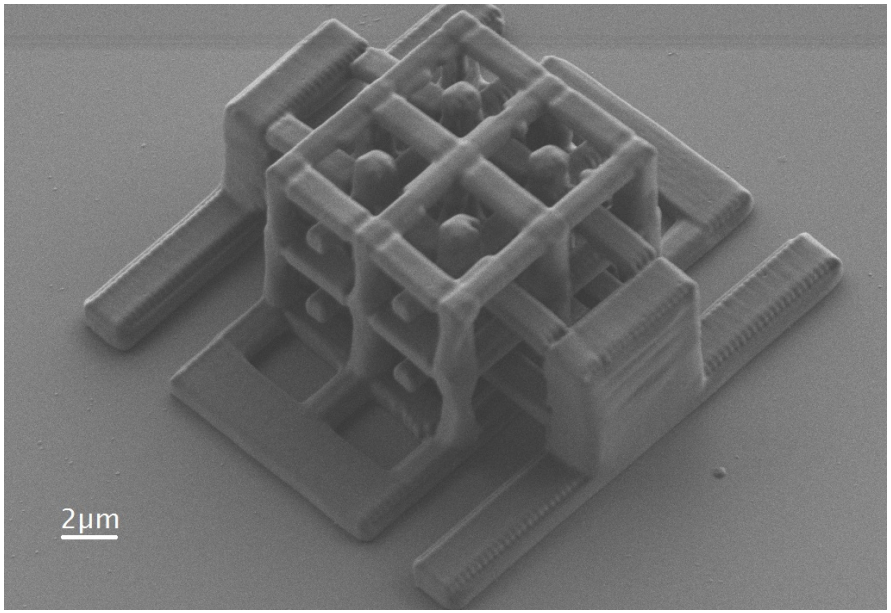
- **ALTRASPIN**

- Key specifications:
  - High resolution (0.2µm)
  - Adjustable writing resolution for high-speed
  - cm^2 printed surface, on flat or non-flat substrates (up to 100x75mm^2)
  - Any 3D shape
  - Compatible with a large range of polymer materials, including biomaterials
  - Intuitive software, with customer specific plug-ins

Realisation example

- Extra-small objects :

9-µm-high structure (1µm-wide bars)



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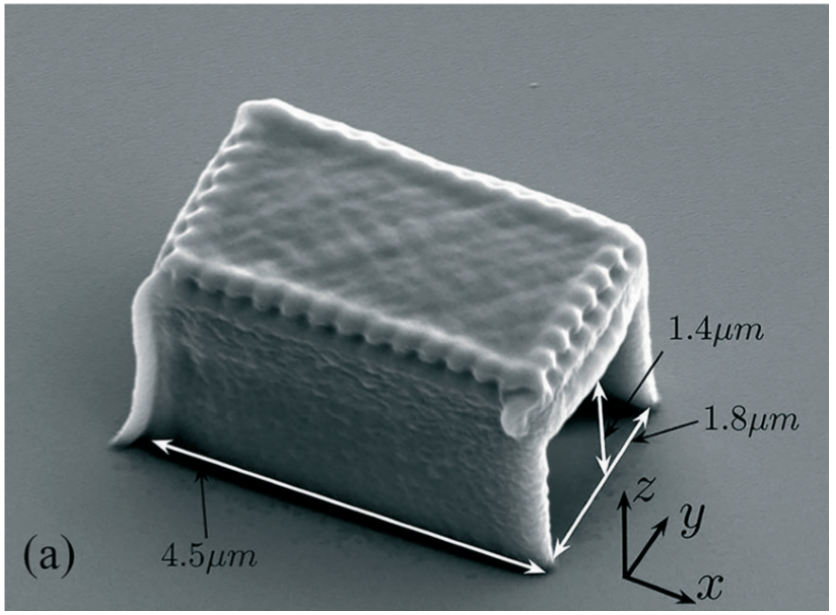
2-µm-high bacteria cage

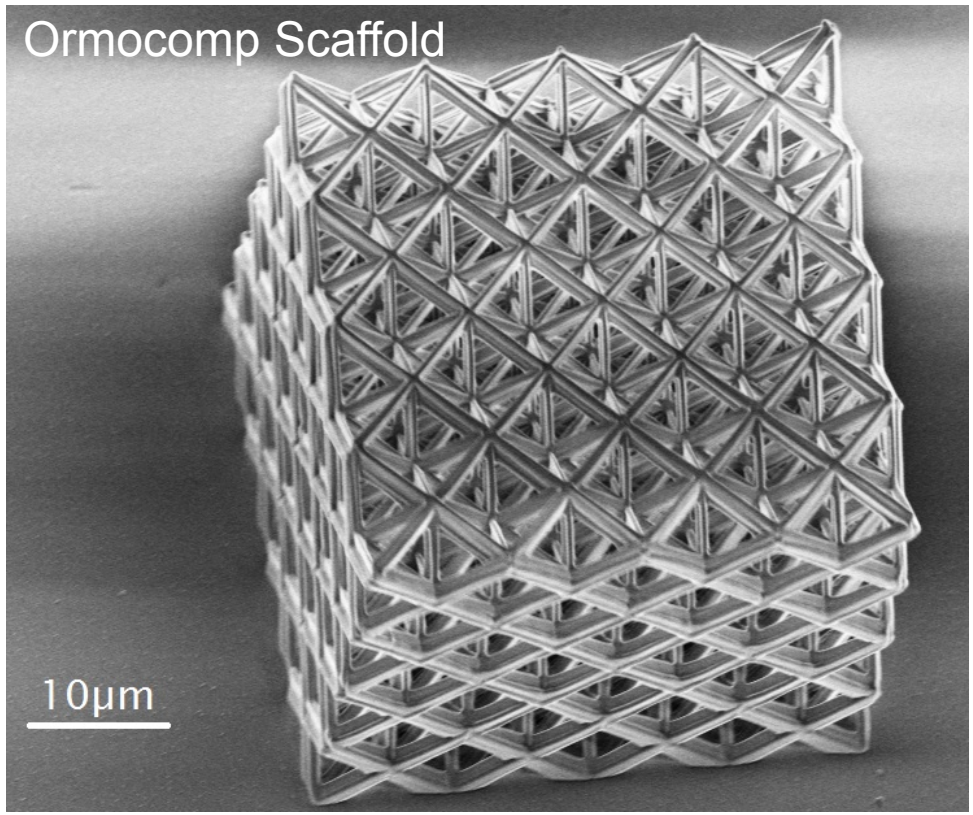


Using confined bacteria as building blocks to generate fluid flow
Zhiyong Gao, He Li, Xiao Chen and H. P. Zhang

DOI: 10.1039/c5lc01093d

Realisation example

- Scaffolds – for metamaterials or cells studies



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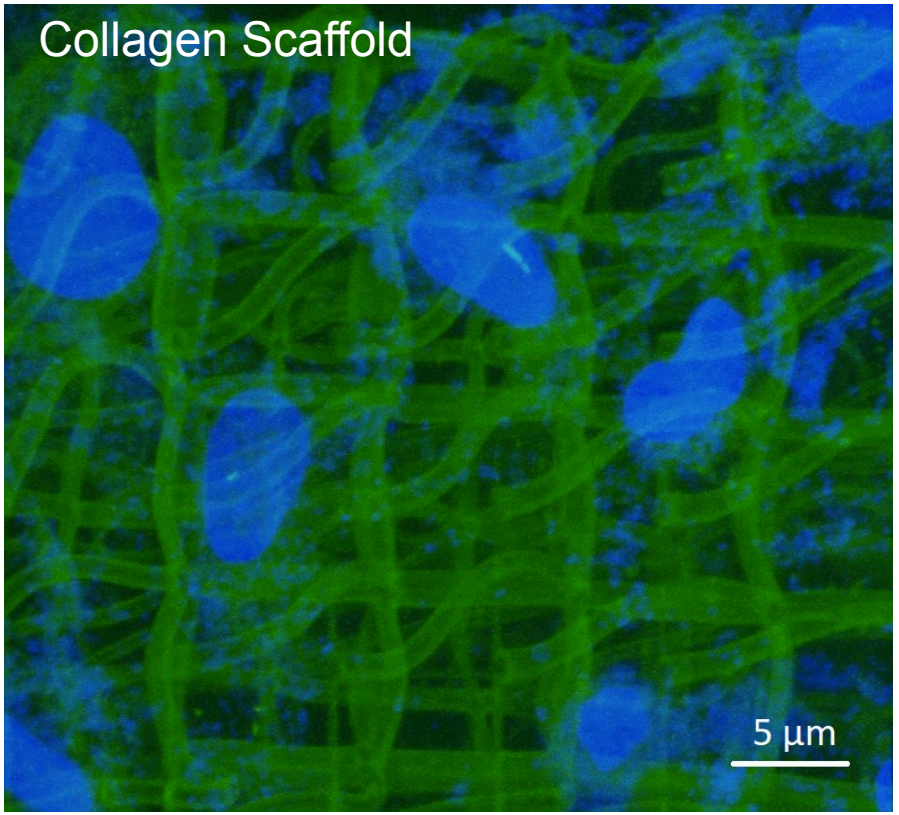

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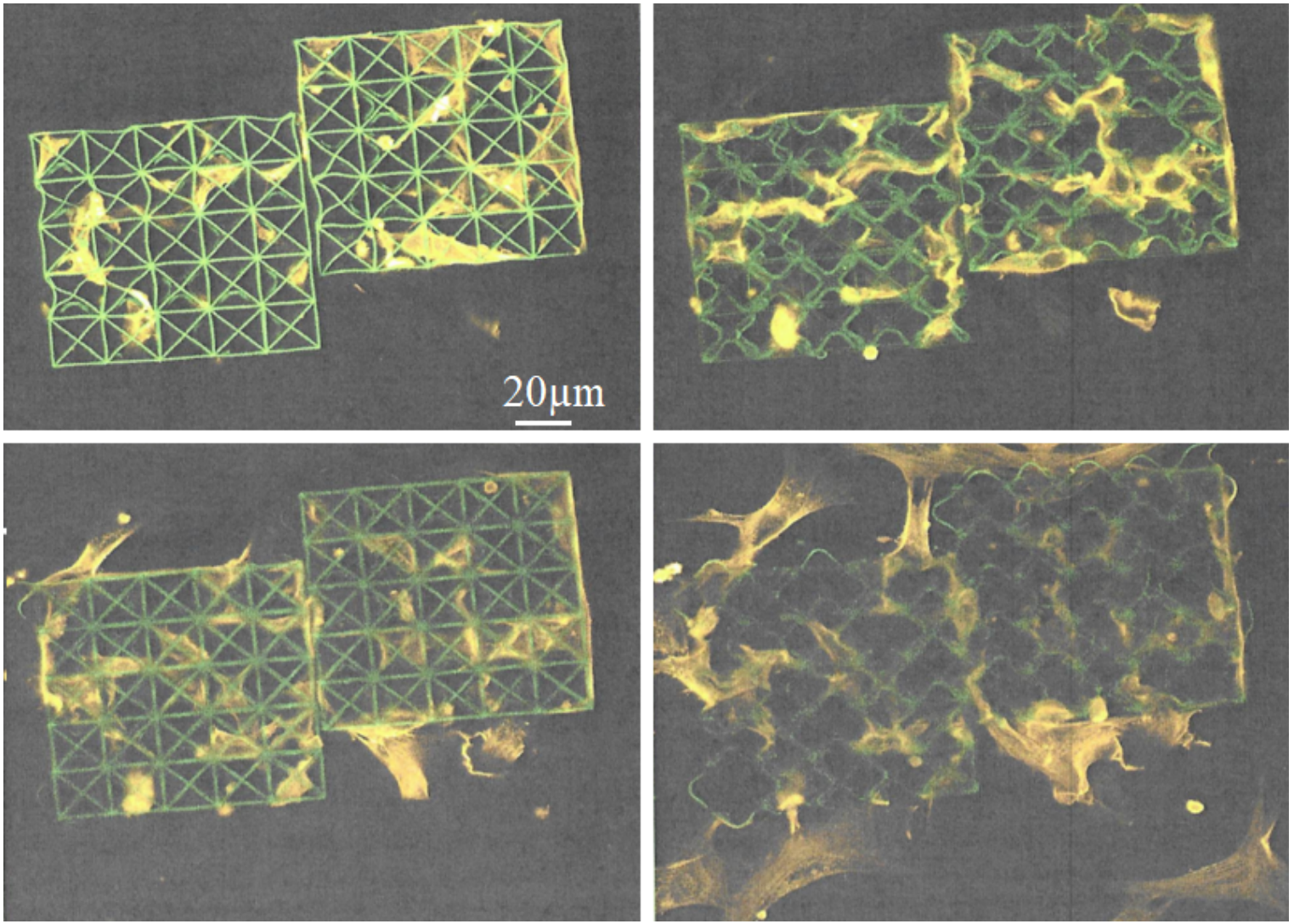
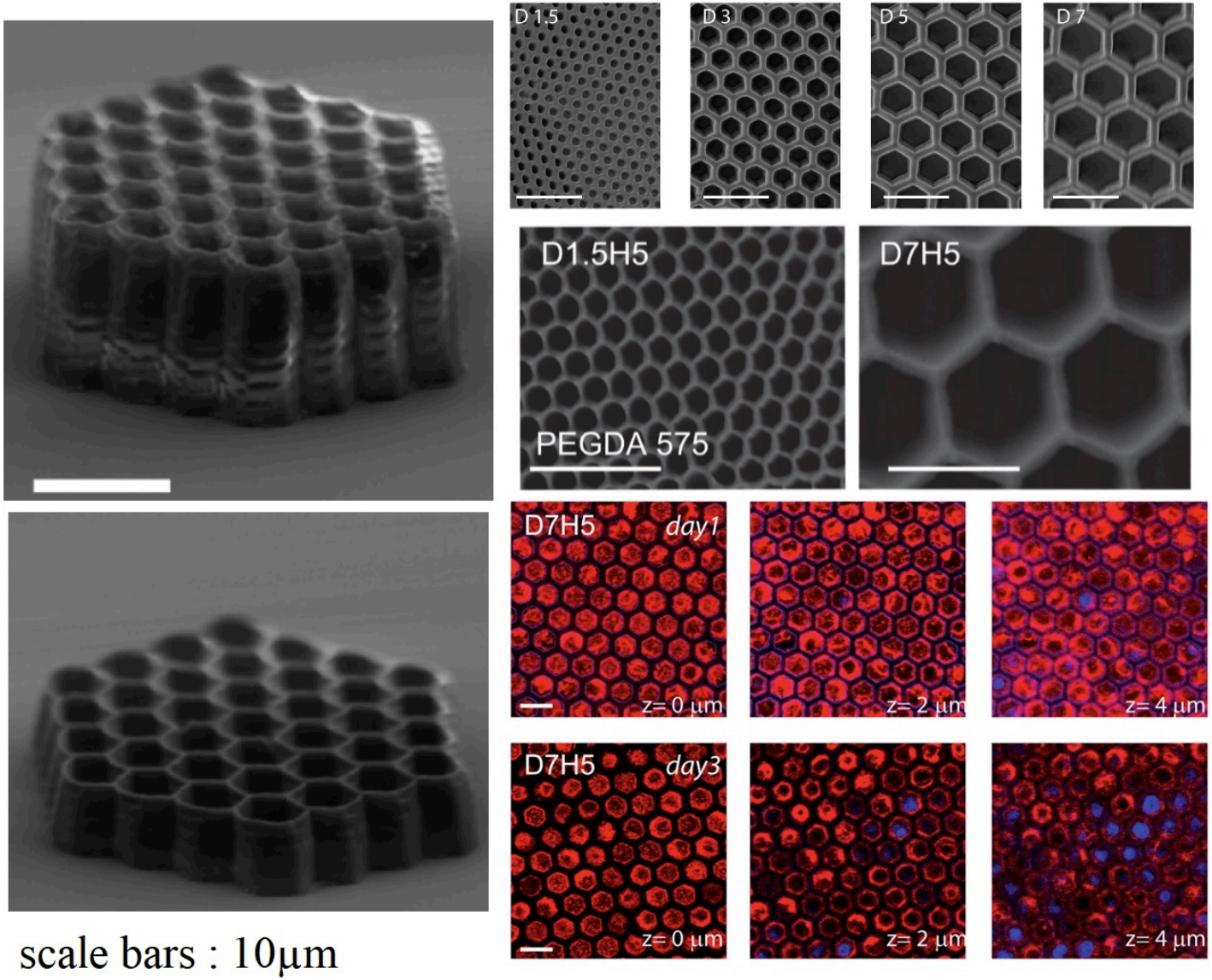
Realisation example

- Scaffolds for cells studies: Ormocomp + fibronectin + fibroblast



Realisation example

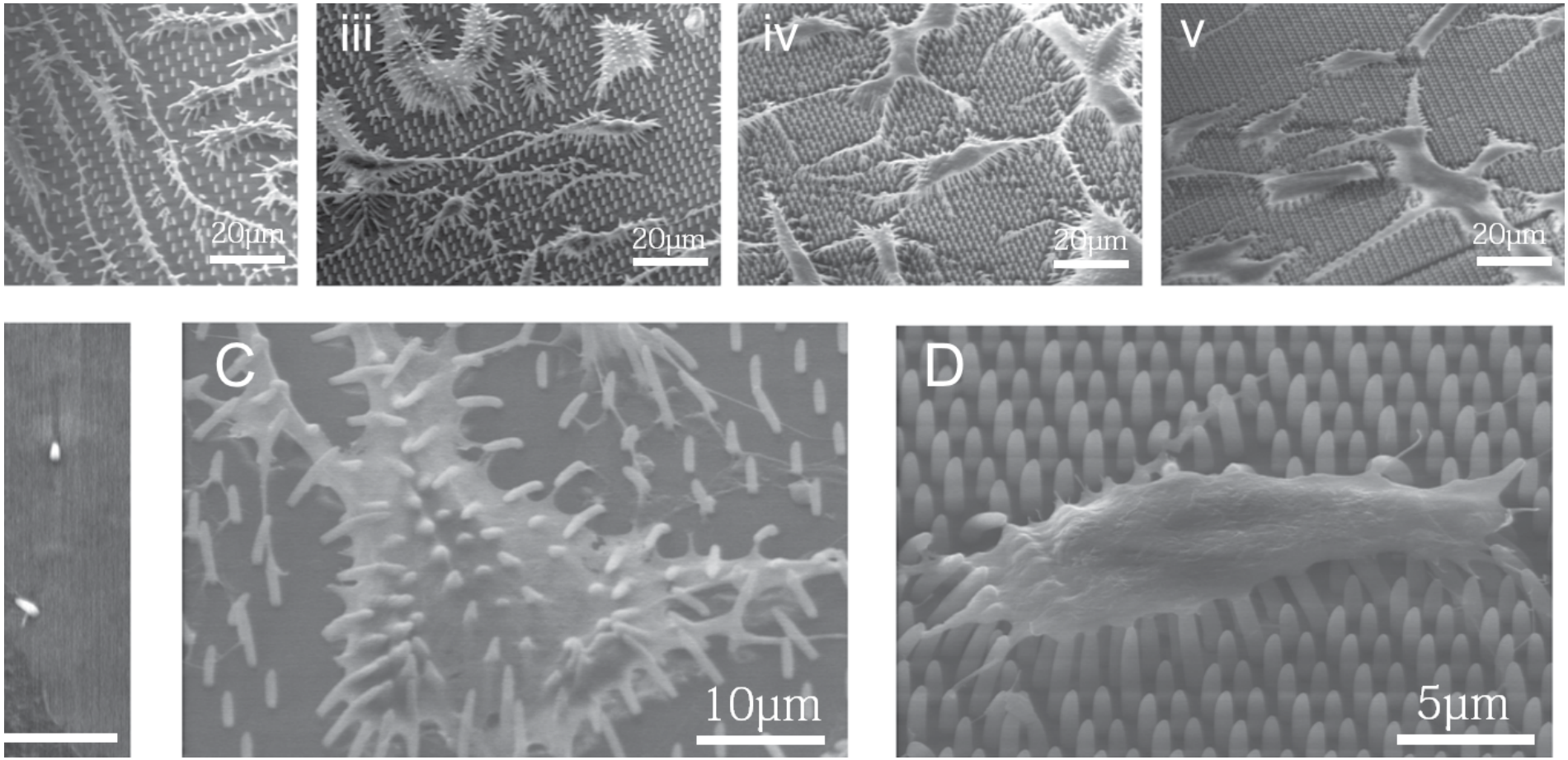
- Scaffolds for cells studies: PEG-DA + Epithelial Cells



scale bars : 10µm

Application example

3D-printing of nanopillars array to measure cell behavior



Rapid Prototyping of Polymeric Nanopillars by 3D Direct Laser Writing for Controlling Cell Behavior
Nina Buch-Månson, Arnaud Spangenberg, Laura Piedad Chia Gomez, Jean-Pierre Malval, Olivier Soppera & Karen L. Martinez
Scientific Reports 2017

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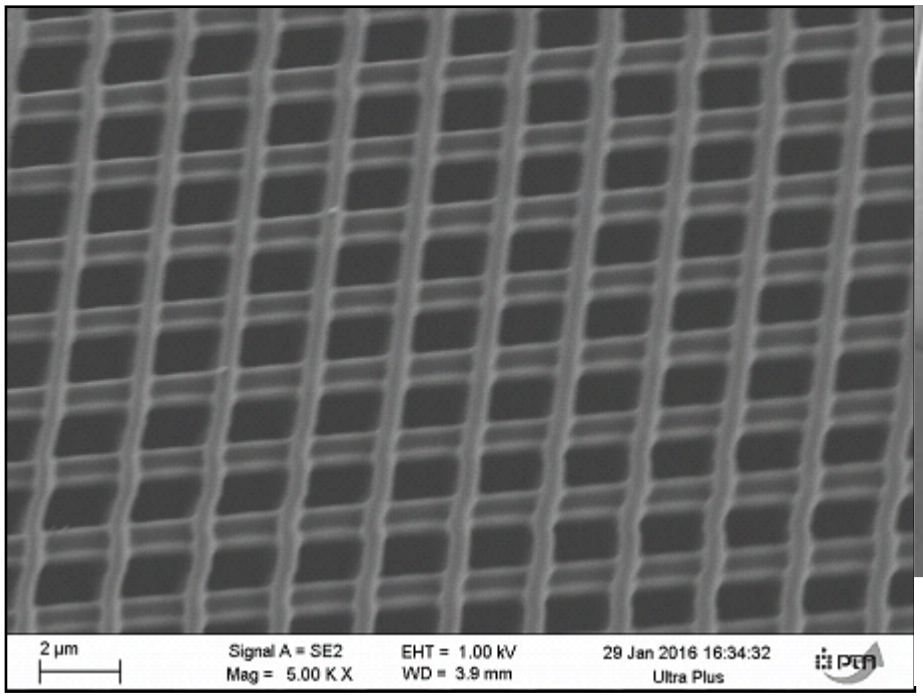
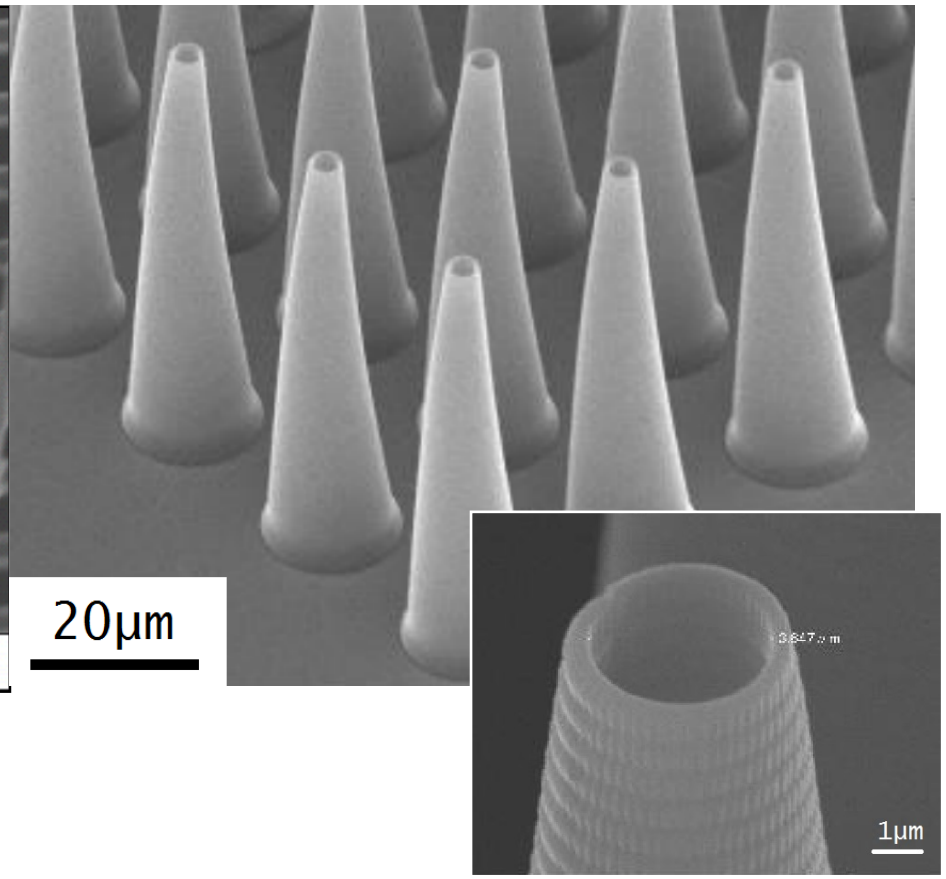
Realisation example

- Cells filter



- Micro needles



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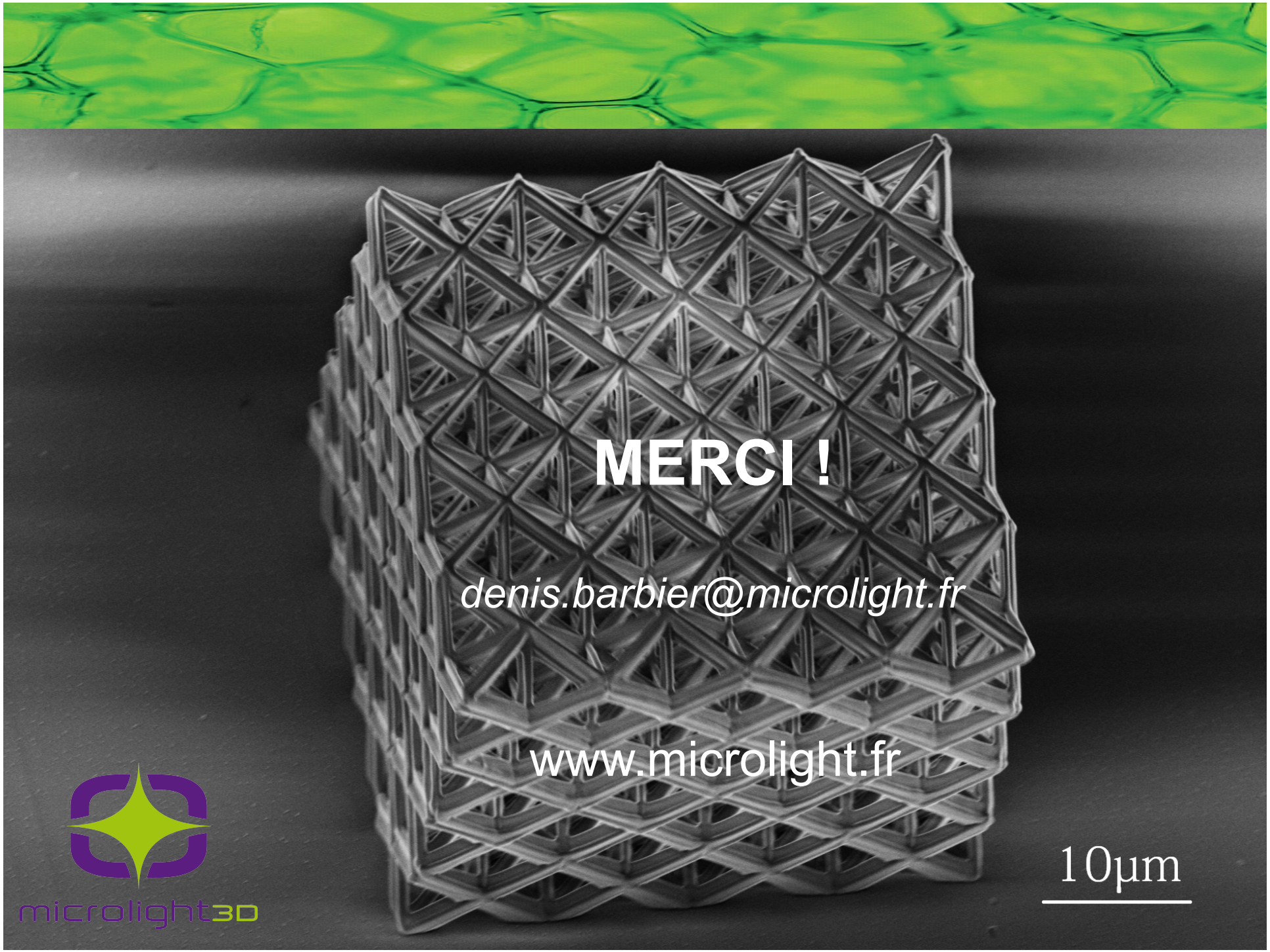
Direct laser writing with sub-micron resolution

- The 2PP, a novel laser-based writing technology, for real 3D with sub-micron resolution.
- A patented optical architecture for high-speed writing
- A laser-path optimisation software, for high-speed 3D shape writing, while preserving complexity and reproducibility
- Compatible with a wide range of polymers and biological materials


MERCI !
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10µm
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