PHOTOSYNTHETIC

Infinite microprinting solutions for
real-world challenges

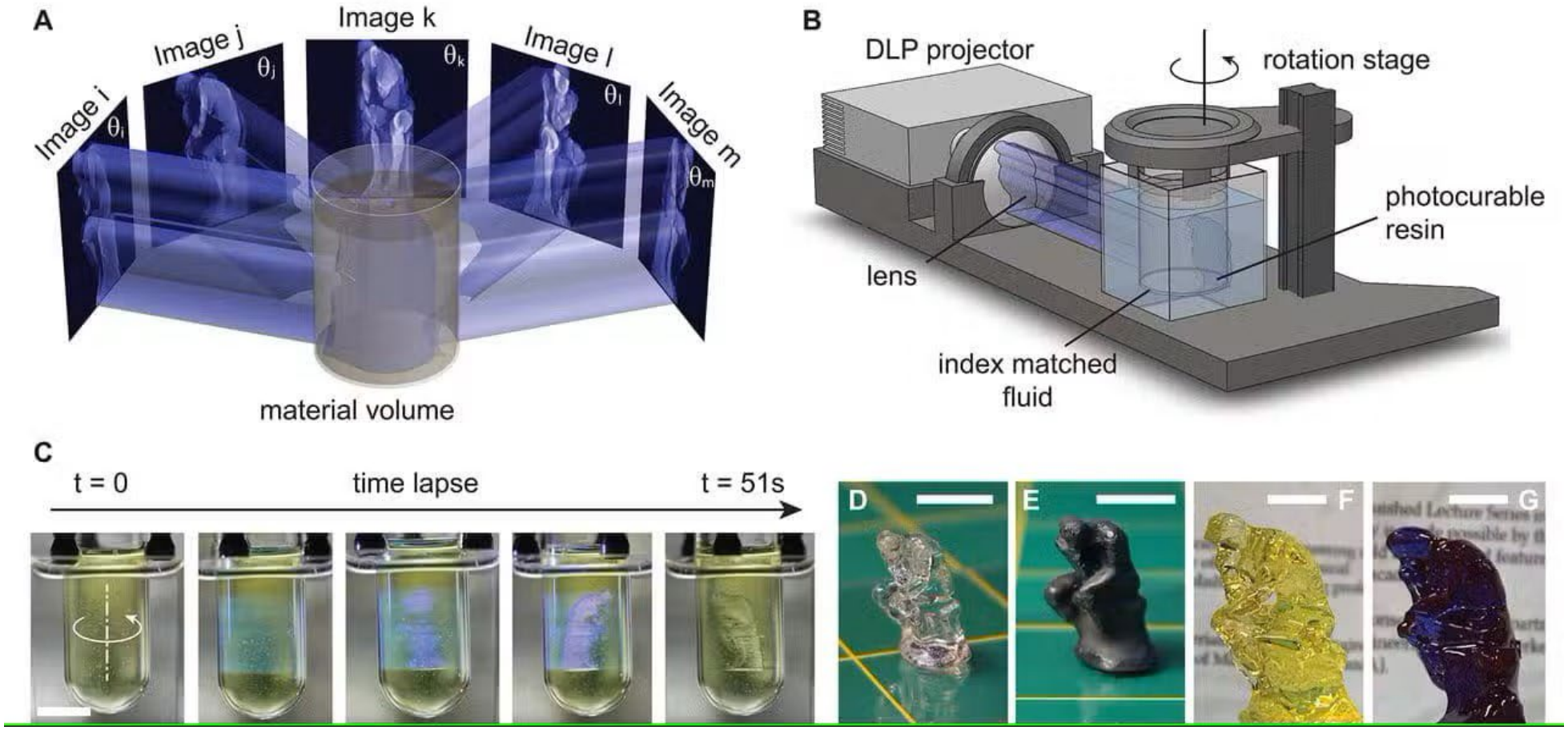
2024

From X-ray CT to 3D printing

CWI
Research institute for mathematics & computer science in the Netherlands

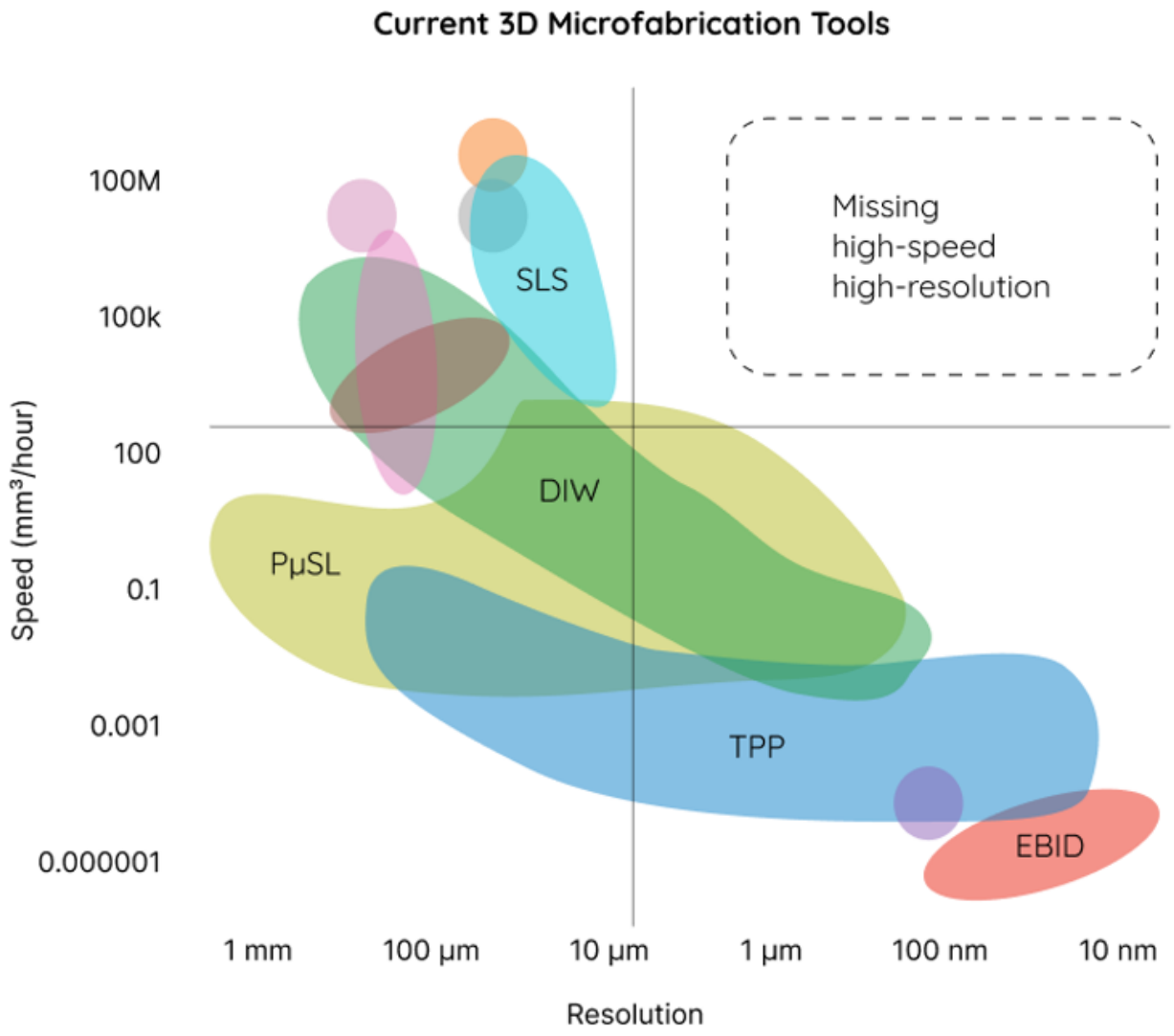
VU VRIJE UNIVERSITEIT AMSTERDAM

Computed Axial Lithography [UC Berkeley]

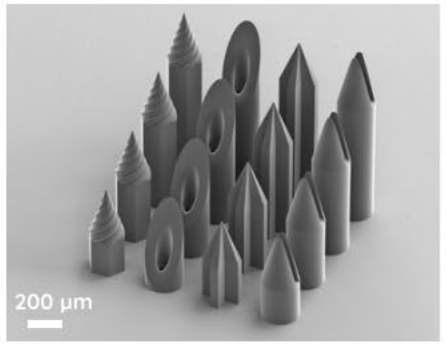


*Brett E. Kelly *et al., V*olumetric additive manufacturing via tomographic reconstruction.*Science***363**,1075-1079(2019).DOI:10.1126/science.aau7114

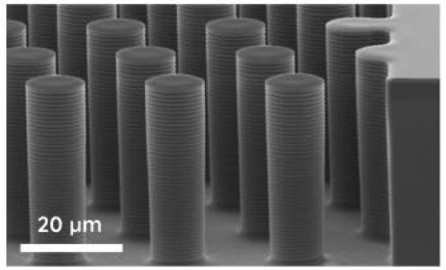
High Impact Innovations at the Micro-scale

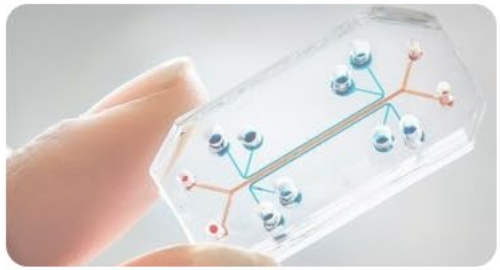


High Impact Innovations at the Micro-scale

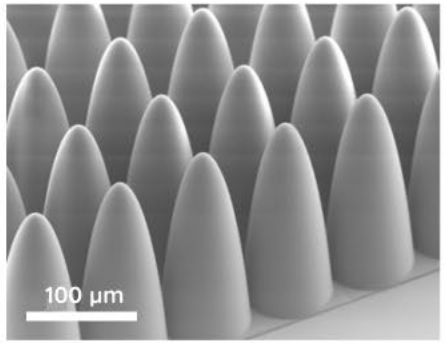


Self-vaccination





Portable diagnostics

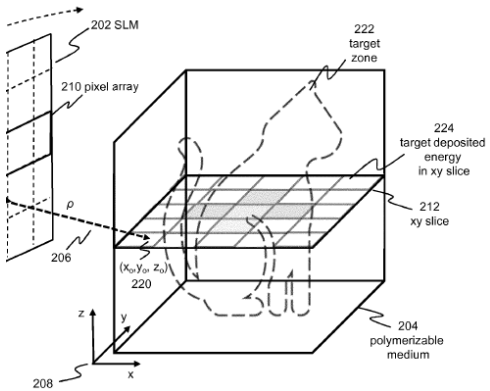


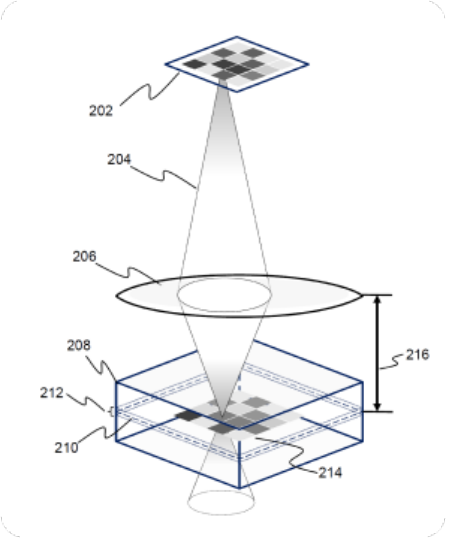
Compact optical devices

*Courtesy of Nanoscribe

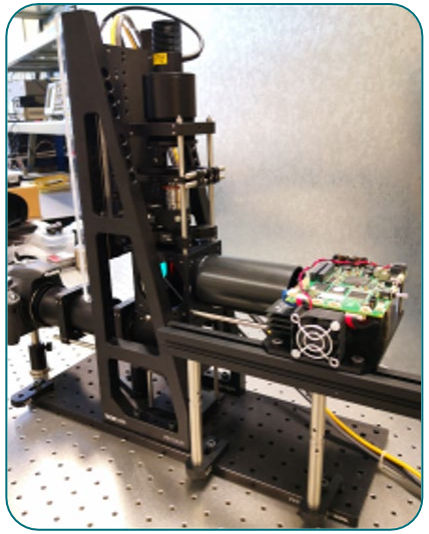
From Concept to Applications

Patents





Proof-of-principle



Prototype

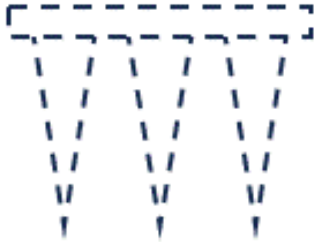
Prints

2019 | 2020 | 2021 | 2022 | 2023 | NOW

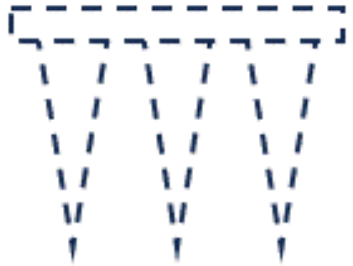
Volumetric Micro-Lithography

Stereolithography - SLA (1984)

Two-Photon Lithography - TPL (1990)



Volumetric Micro-Lithography (2020)

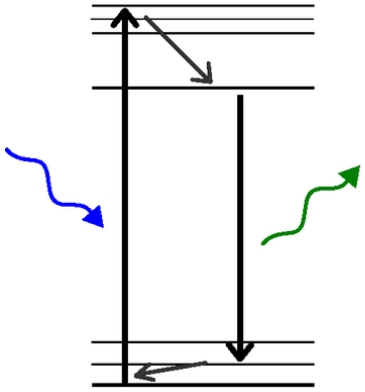


Patented technology

1000x faster than TPL

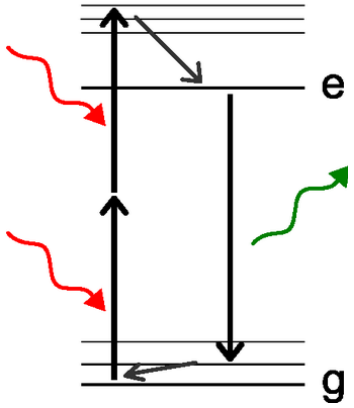
100x smaller features than SLA

One Photon Absorption



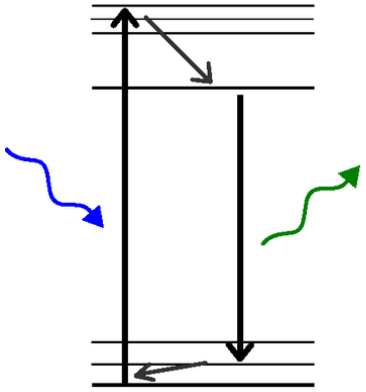
$10^3 W/cm^2$

Two Photon Absorption



$10^{12} W/cm^2$

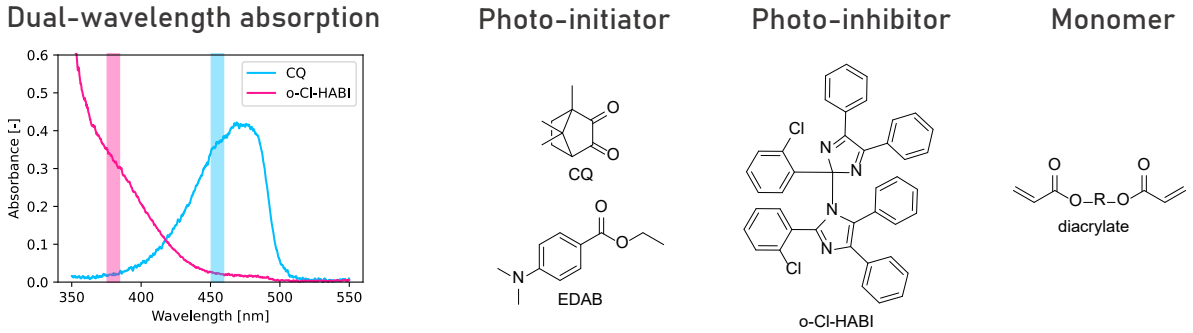
One Photon Absorption



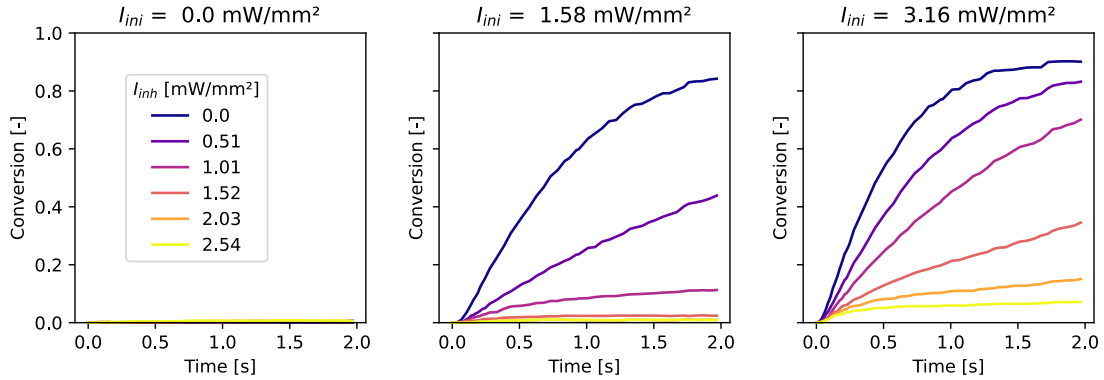
$10^3 W/cm^2$

OPTICAL RESIN CALIBRATION: Fitting Kinetics

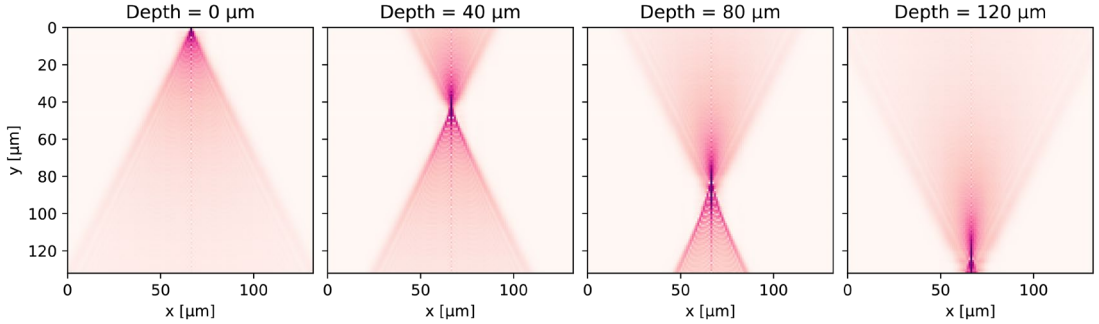
Dual-wavelength Photopolymerization process:



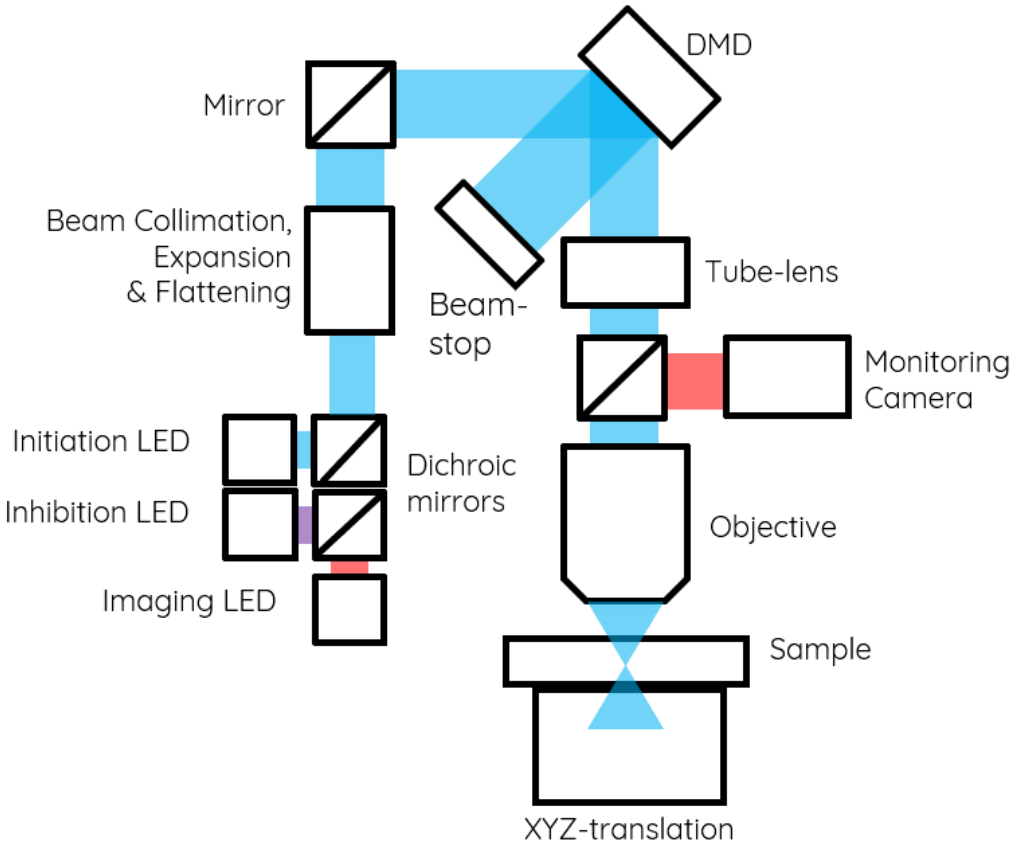
Intensity-dependent polymerization kinetics:



Depth-dependent Point-Spread-Function:

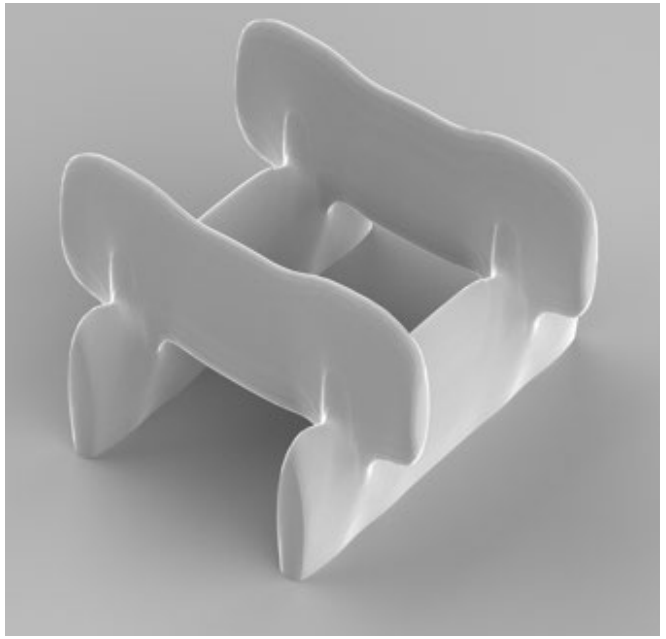


Hardware: DMD-based full-filed illumination

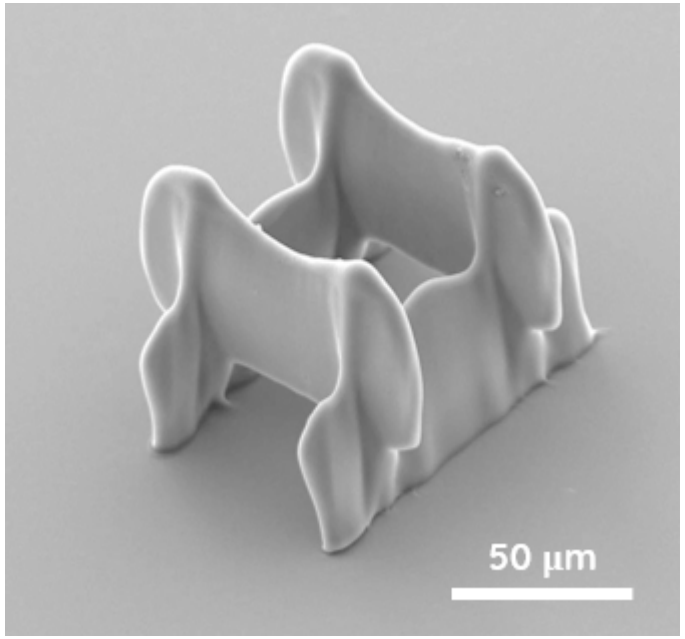


Small Scaffold Print Result

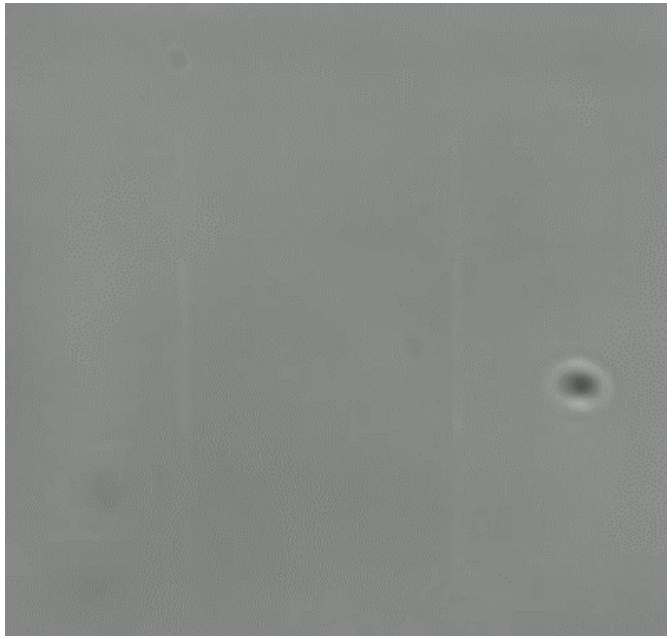
Simulation



Print

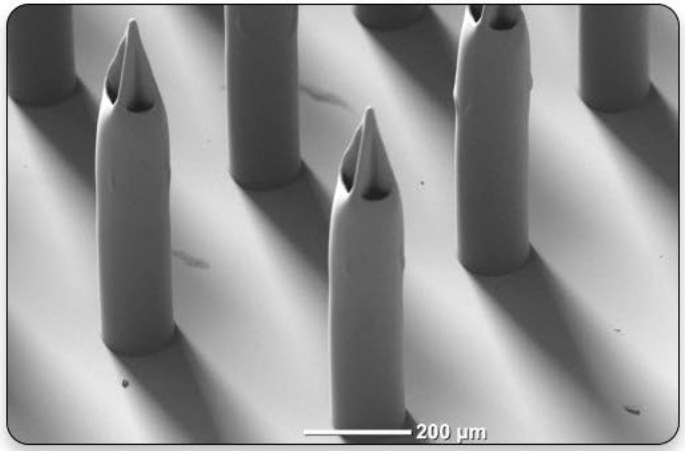


Real-Time Print



Applications

Microneedle Array Patch Technology

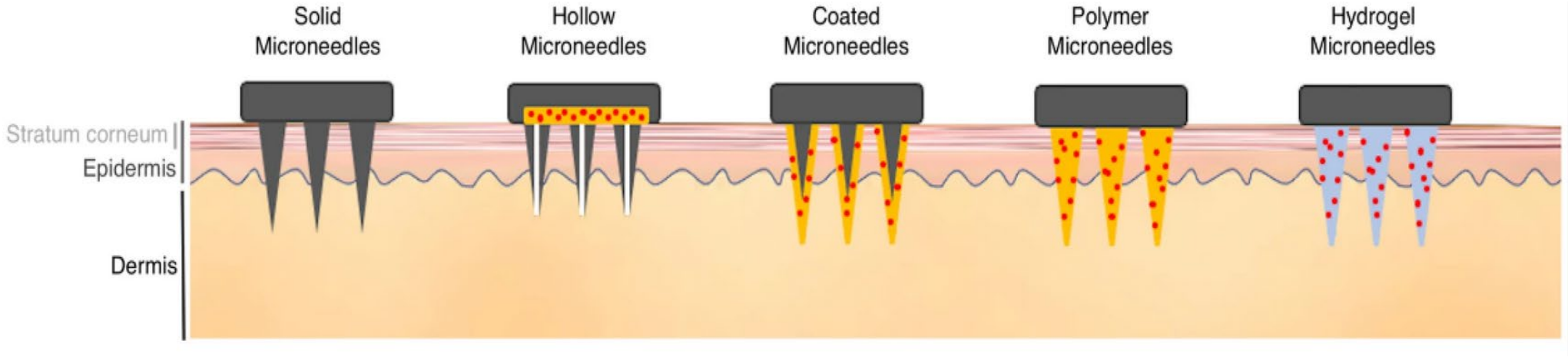


- Dose sparing
- Solid-state vaccines
- No refrigeration

- Aseptic package
- Compact stockpiling
- Rapid response

Global effort led by: unicef WHO BILL & MELINDA GATES foundation BARDA

Major Types of Microneedle Array Patches



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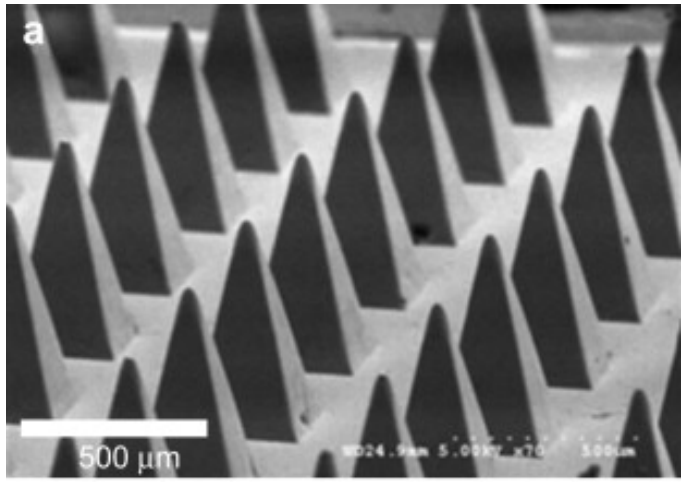
Wang, F.Y.; Chen, Y.; Huang, Y.Y.; Cheng, C.M. Transdermal drug delivery systems for fighting common viral infectious diseases. Drug Deliv. Transl. Res. ***2021****, 11, 1498–1508.*

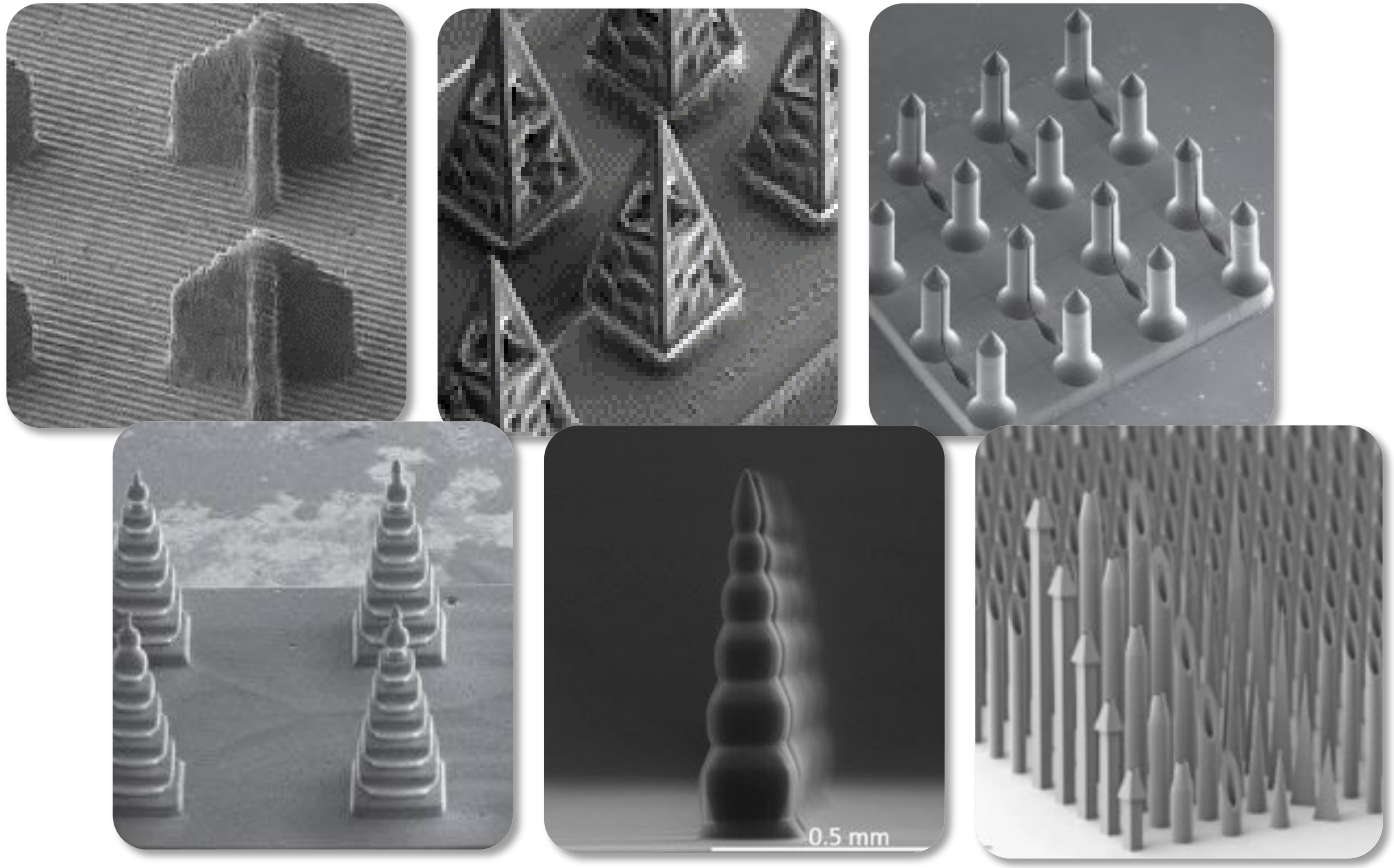
Additive Manufacturing enables better vaccine release mechanisms

Moulding:



Jeong W. Lee et al. 2008

3D Printing:



Uddin et al. 2020; Caudill et al. 2021; , J.M. DeSimone et al. 2022, Rad et al. 2017; Nanoscribe

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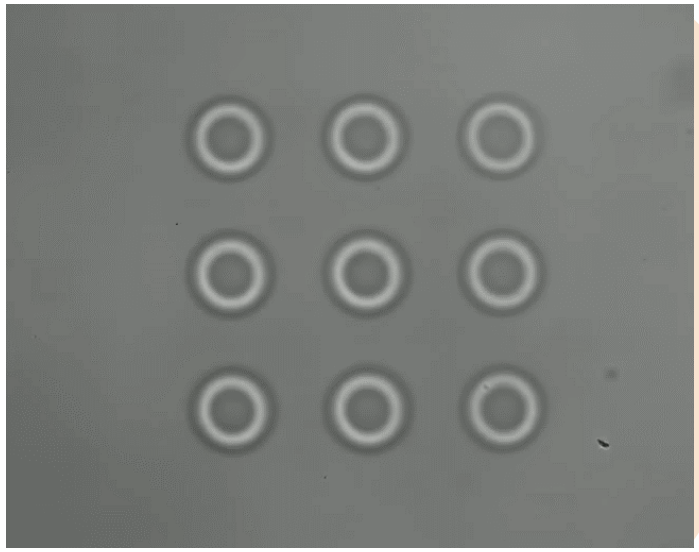
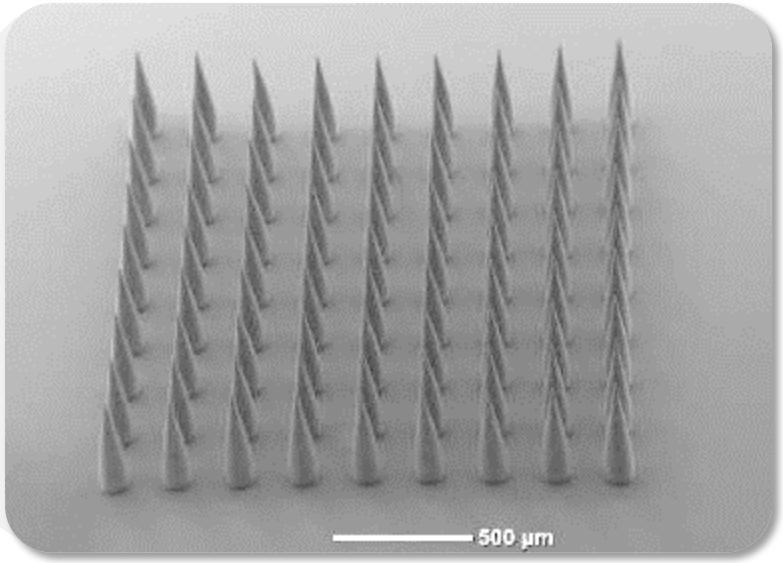
Real-Time Printing Process



2 seconds per tile
at 900 mm³/hour

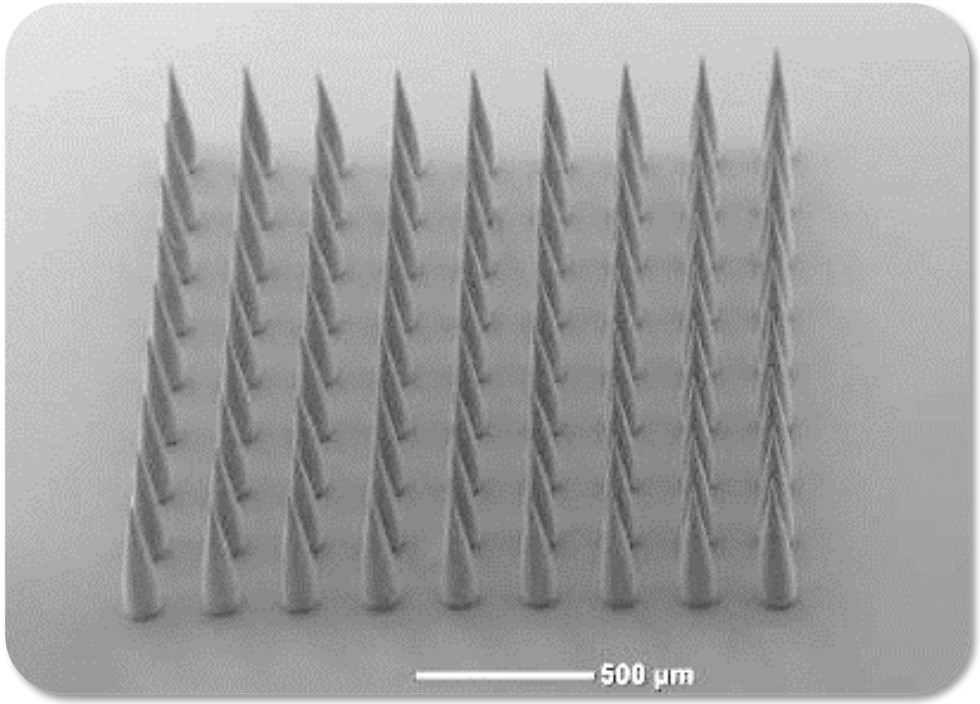
Tile
1 mm x 1 mm

Patch
1 cm x 1 cm x 0.5 mm

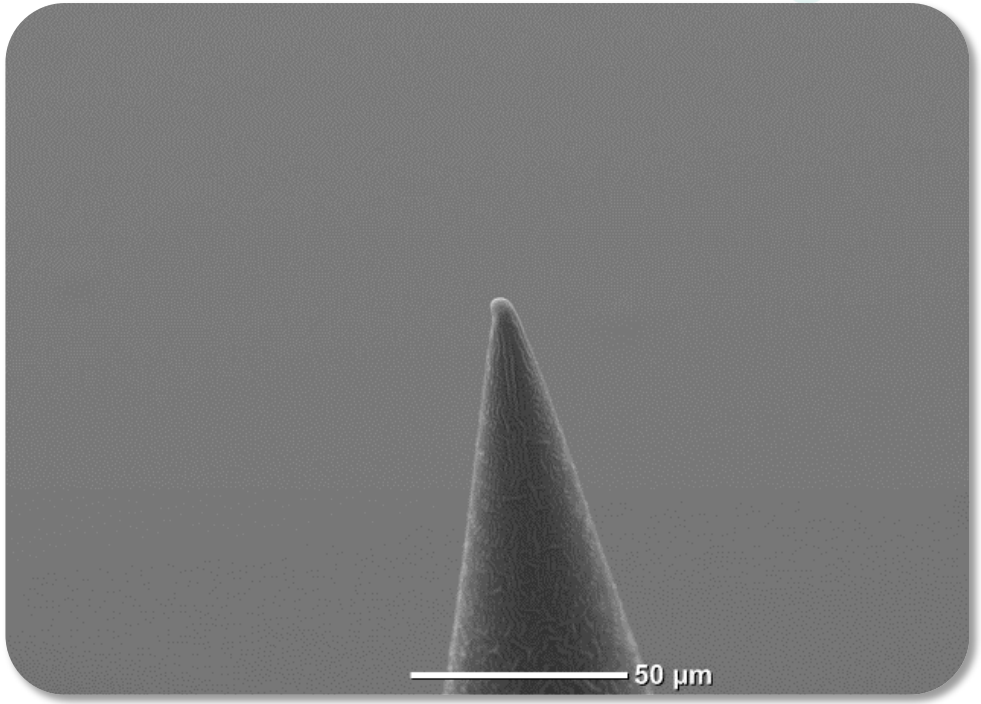


3 minutes per MAP

Printed Cone-shaped Microneedles

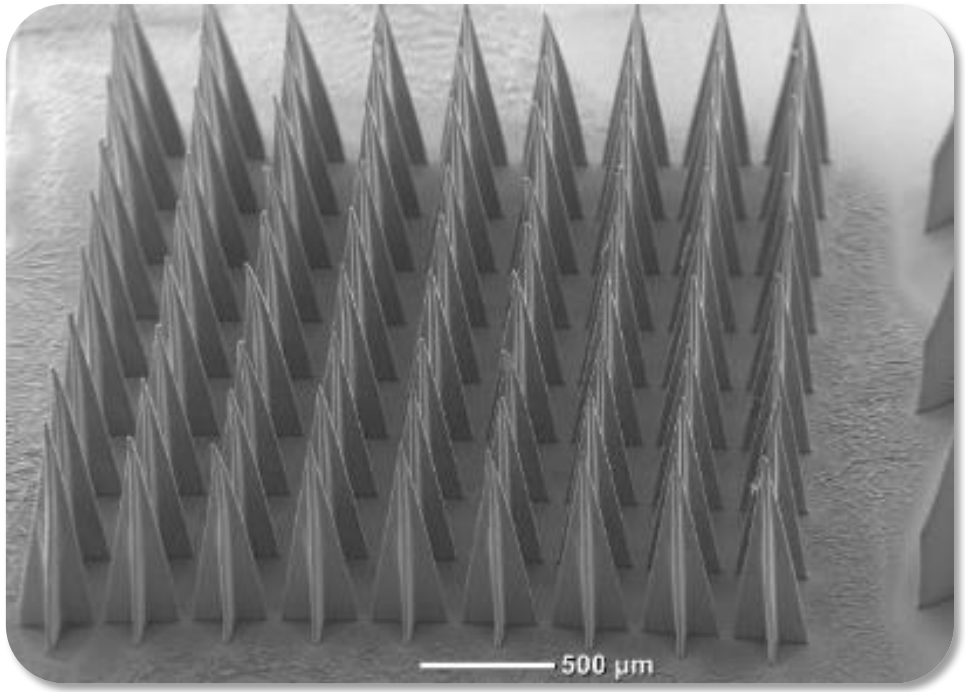


400-micron height

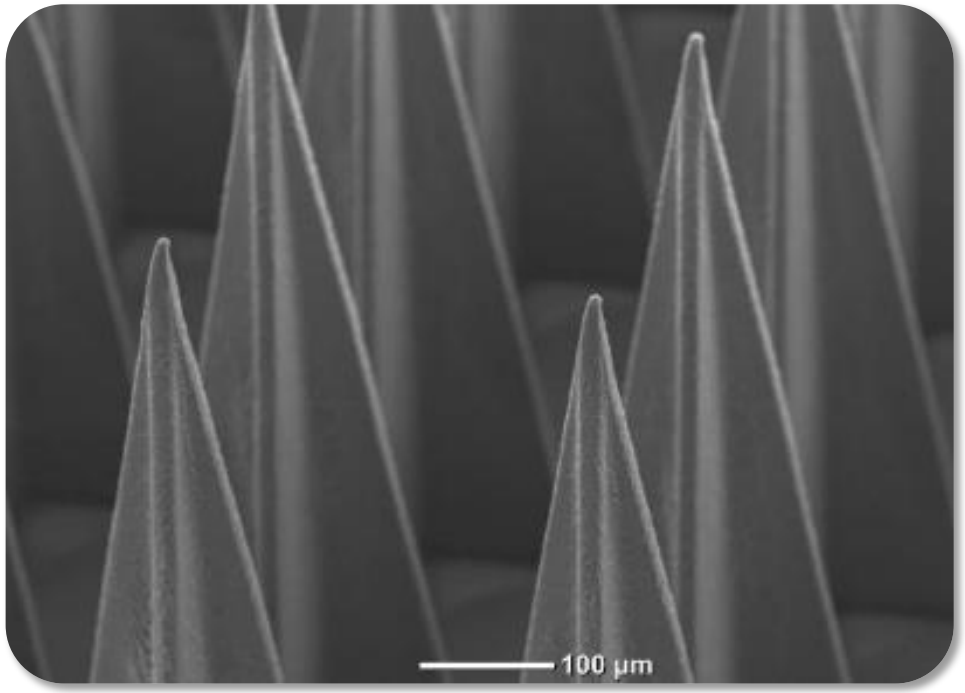


2.5-micron tip radius

Printed Cross-shaped Microneedles

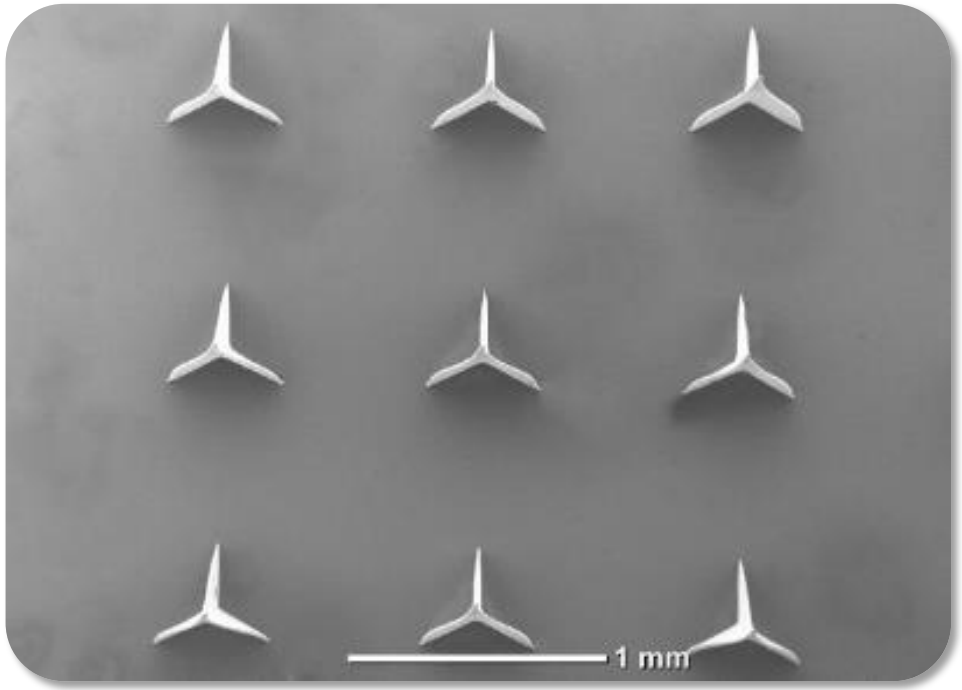


800-micron height

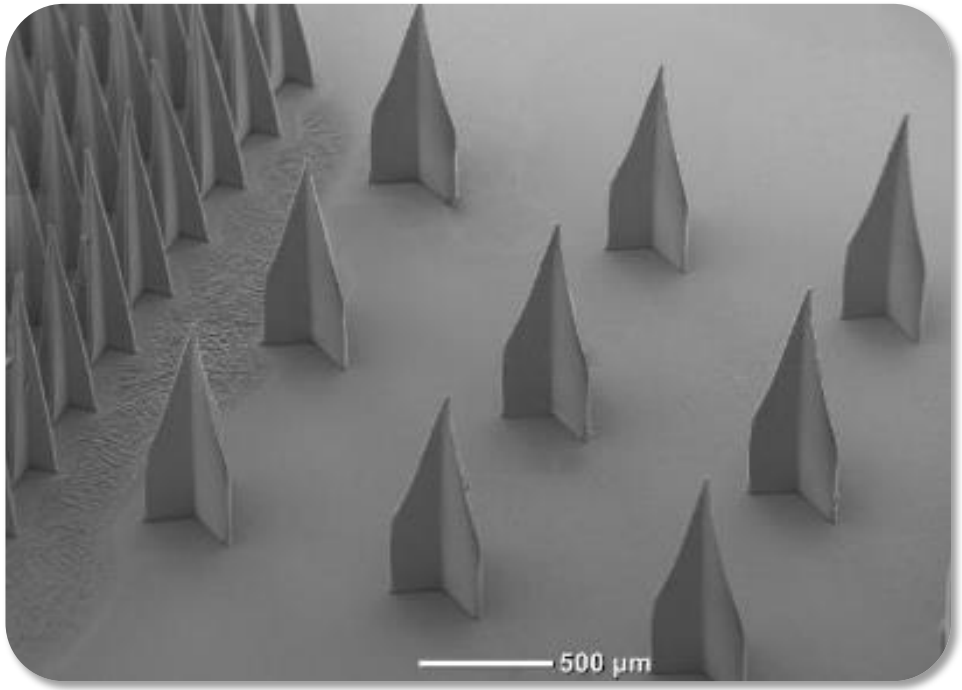


5-micron tip radius
15-micron wall width

Printed Star-Shaped Microneedles

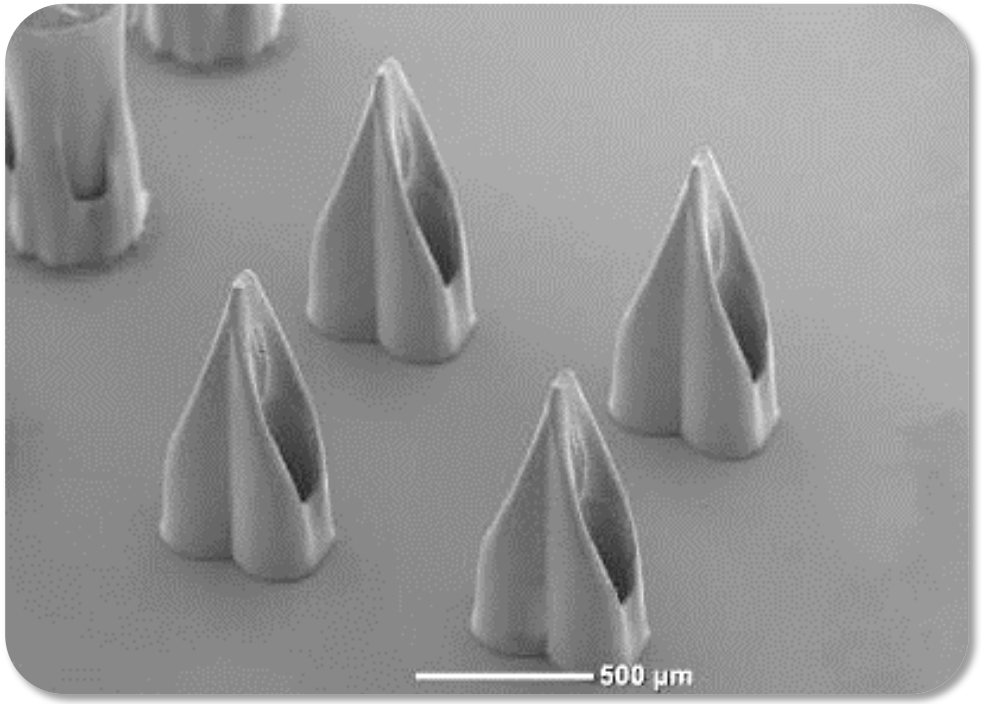


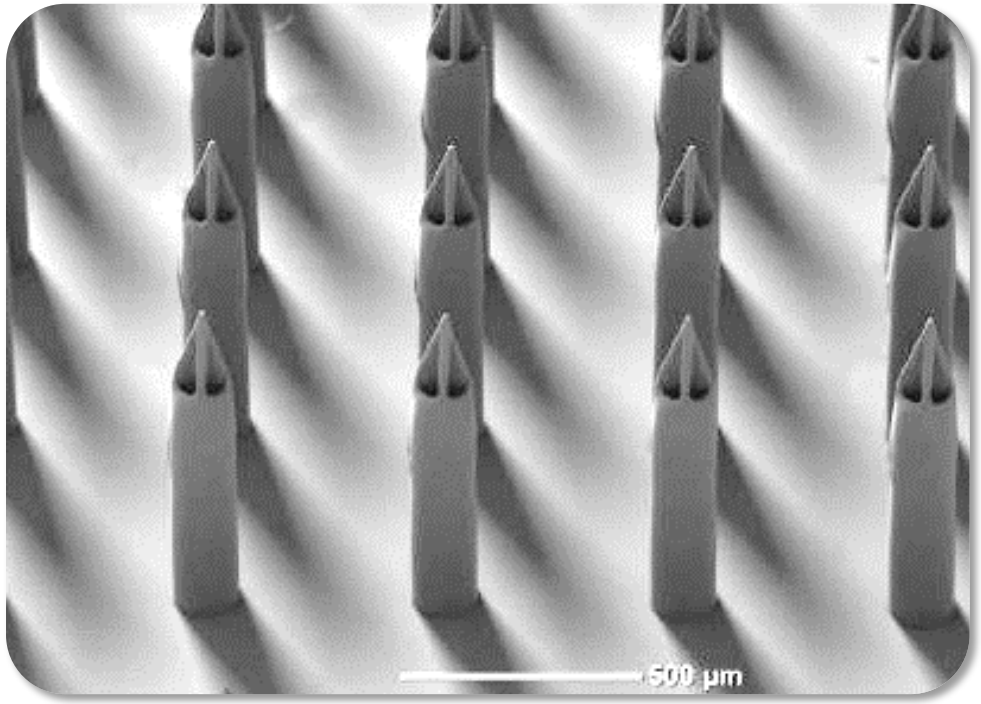
800-micron height



5-micron tip radius
15-micron wall width

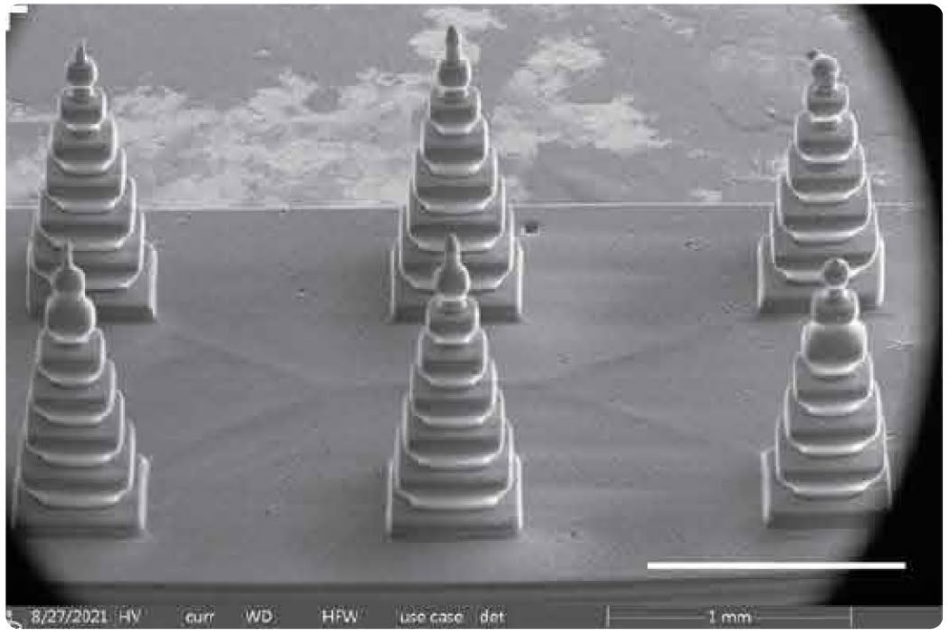
Printed Hollow Microneedles





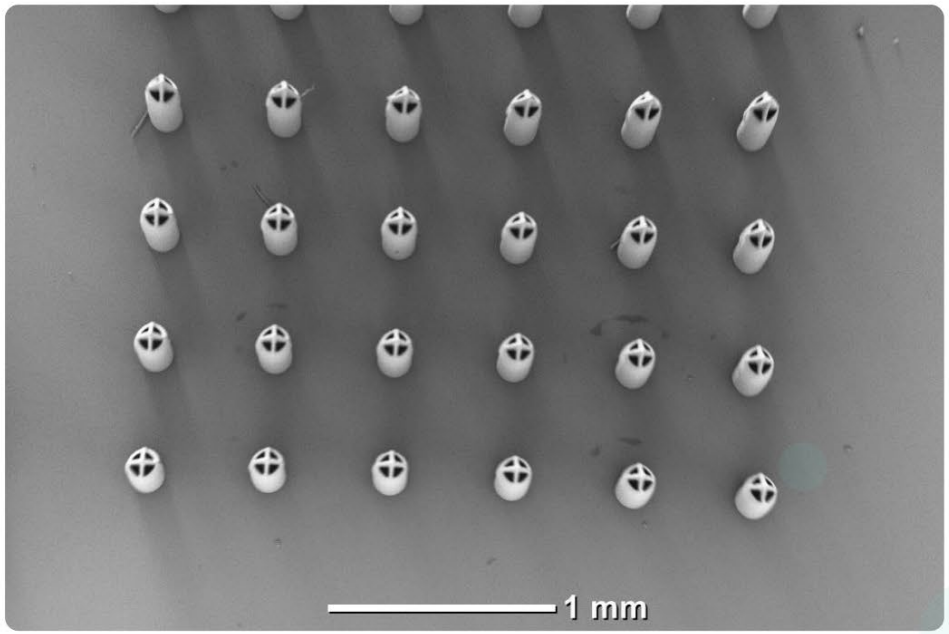
Speed Comparison

Georgia Institute of Technology Stanford University carbon3D



- Current Speed: **120 mm3/h**
- Estimated Unit Cost: **$5-$30**

PHOTOSYNTHETIC NEMAURA MEDICAL



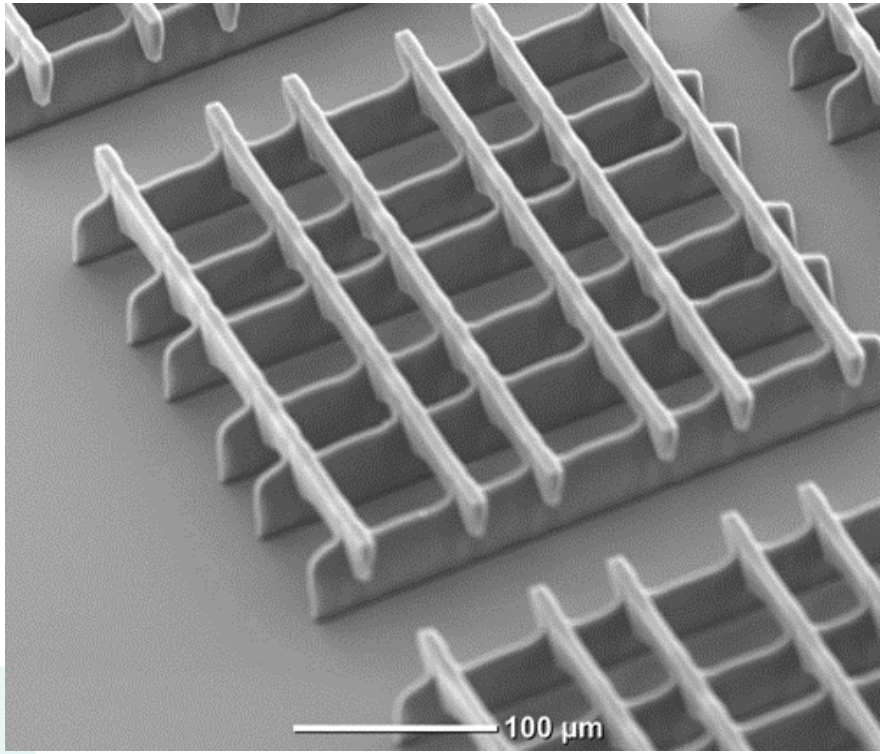
- Current Speed: **800 mm3/h***
- Estimated Unit Cost: **$0.2-$1**

***Achievable speed: 10’000 - 20’000 mm3/h**

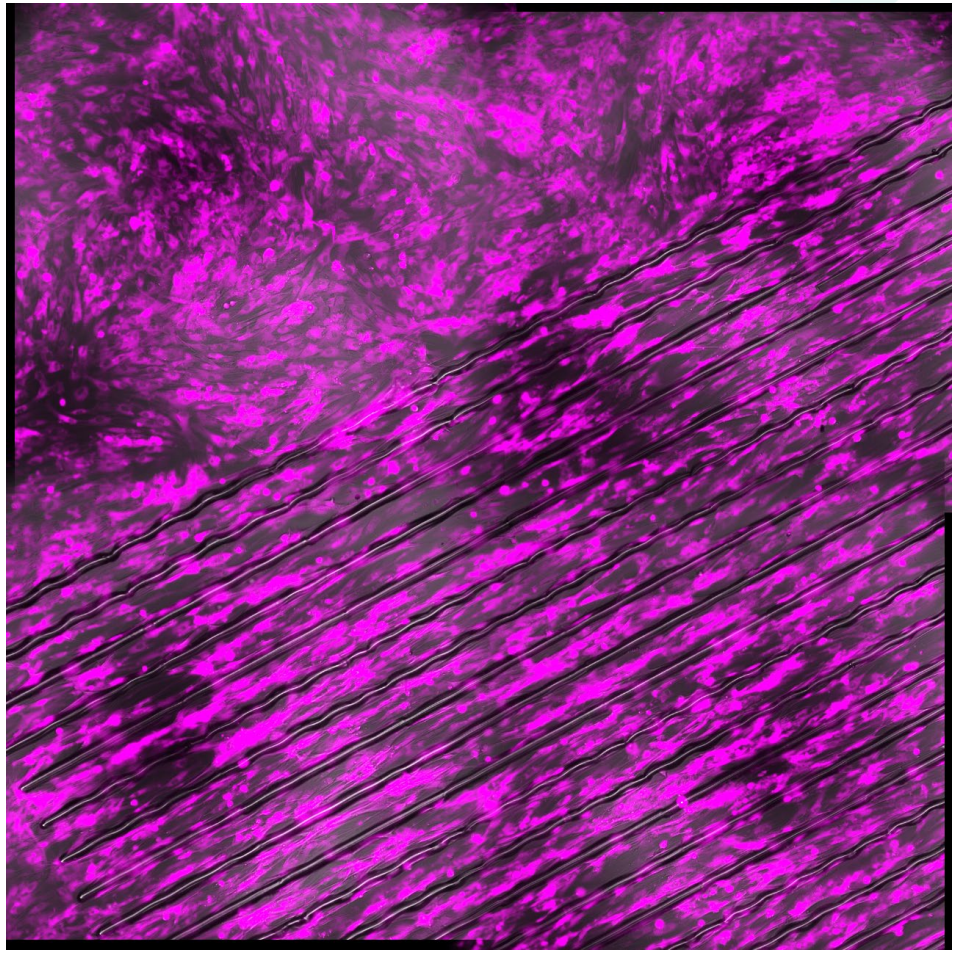
What else can we print?

Bio-scaffolds for mesenchymal stromal cells

Printed 2-layer bio-scaffolds



Cell alignment along printed PEGDA fibbers



Initial test done by Paulina Nunez Bernal and Riccardo Levato at the Translational Bioengineering and Biomaterials, Utrecht University

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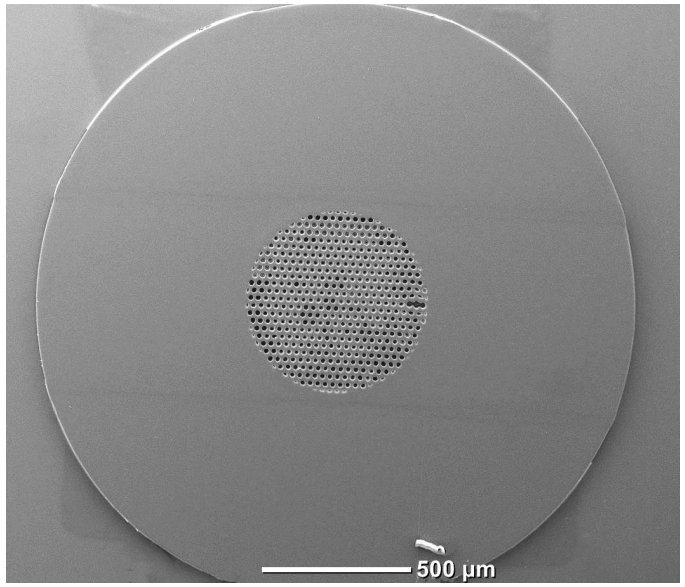
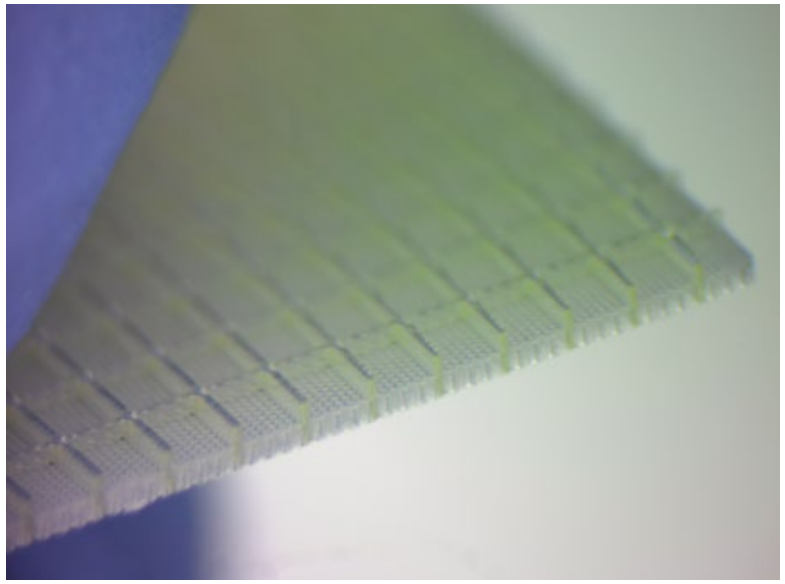
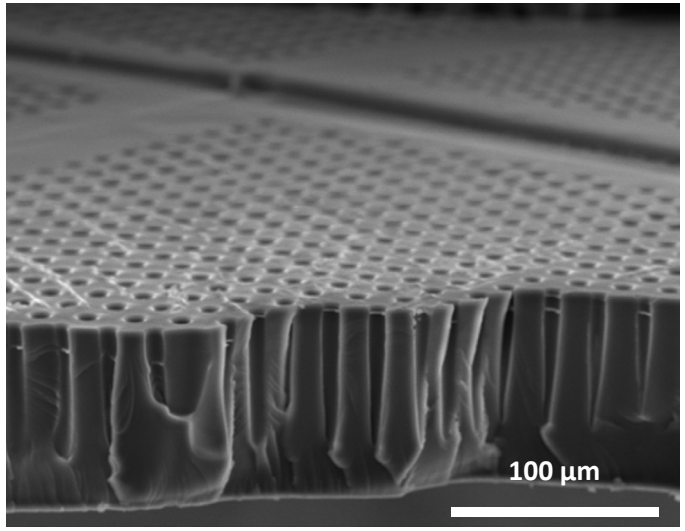
Other applications: membranes for filtration and cell-capture

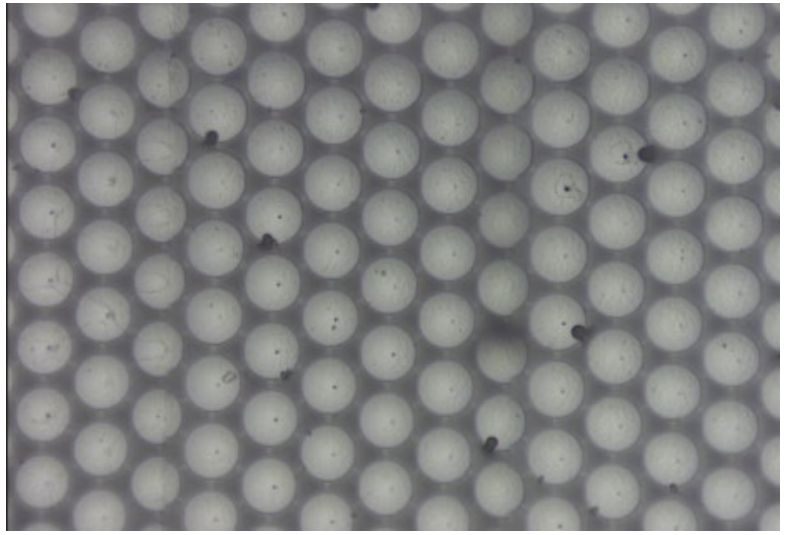
Prototype of a micro-filtration membrane

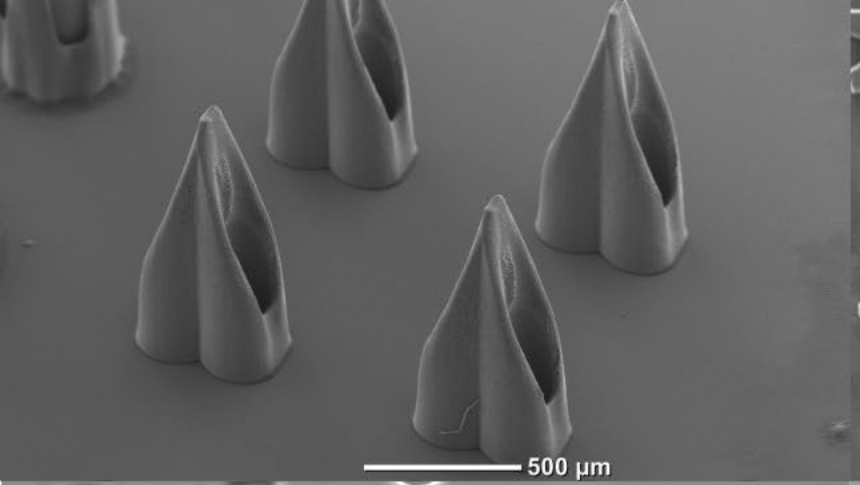


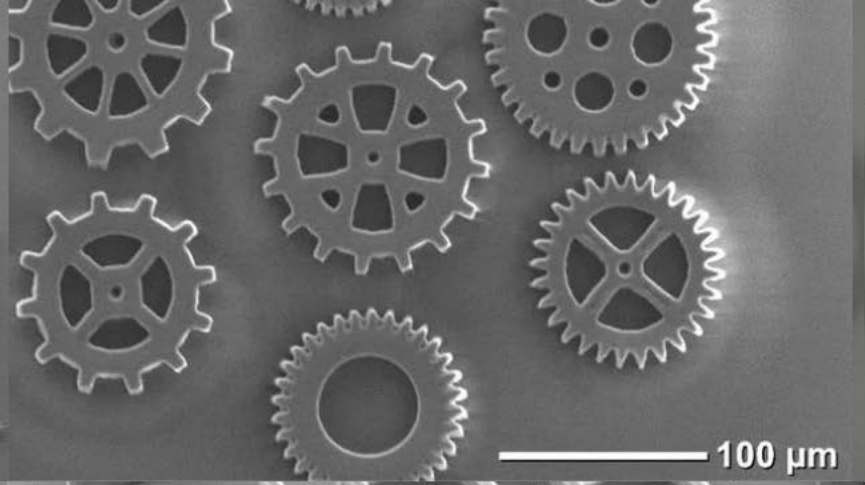
Membranes for cytology applications

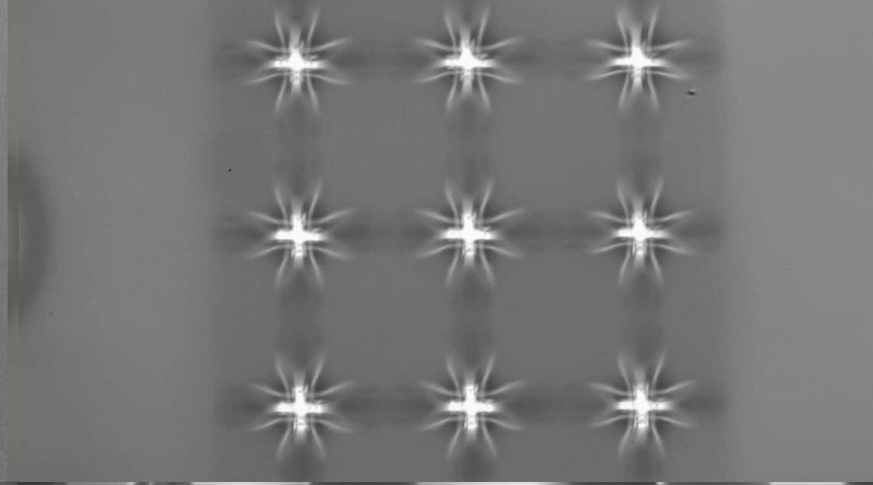


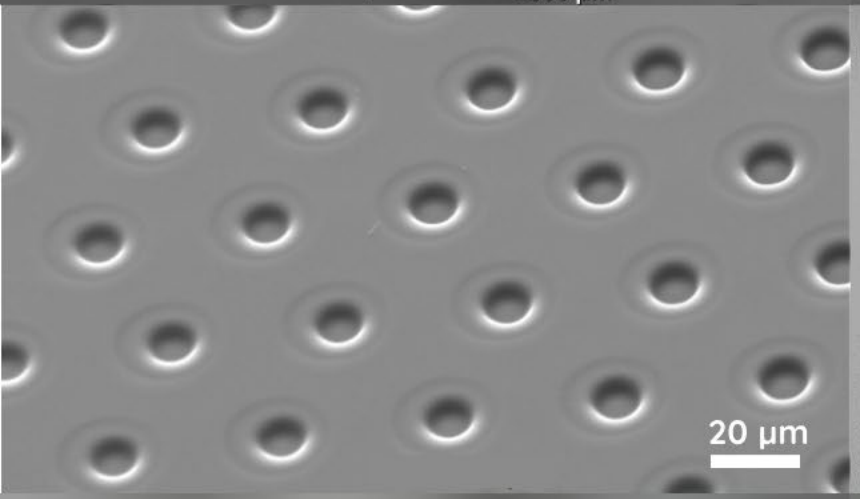


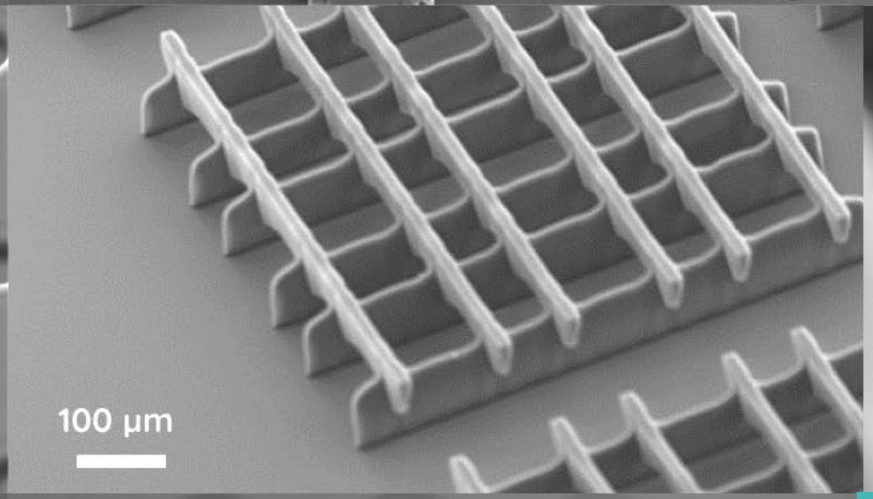


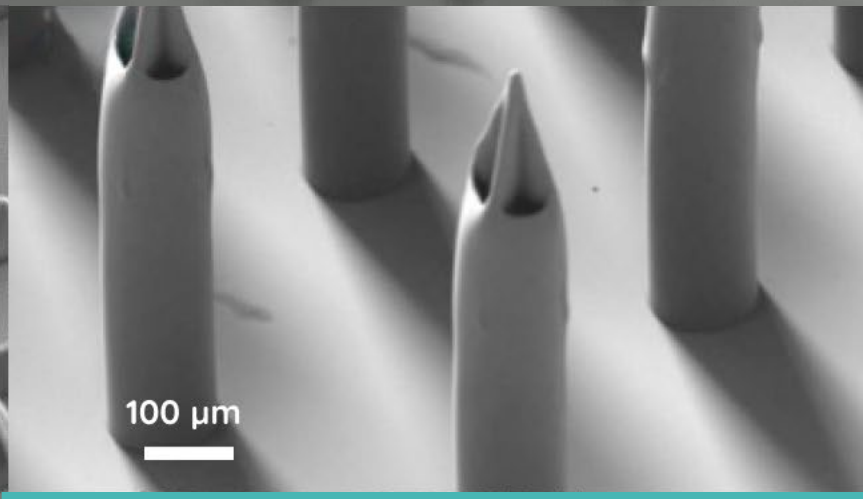

500 µm


100 µm

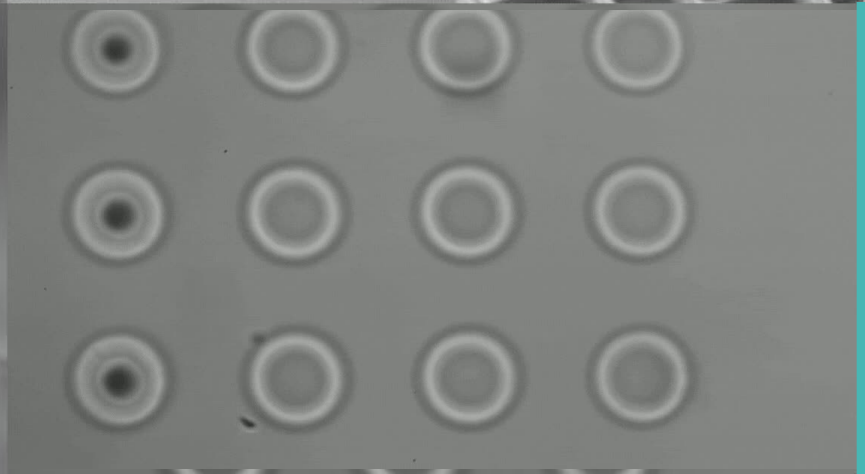


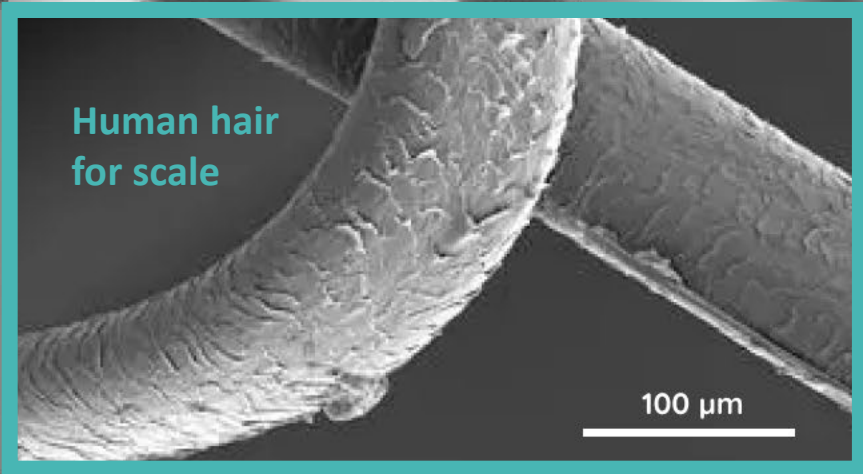

20 µm


100 µm


100 µm


200 µm




Human hair
for scale
100 µm

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hello@photosynthetic.nl

This project has received funding from the Eurostars-2 joint programme with co-funding from the European Union Horizon 2020 research and innovation programme

Enabling production-speed additive manufacturing at the micro-scale