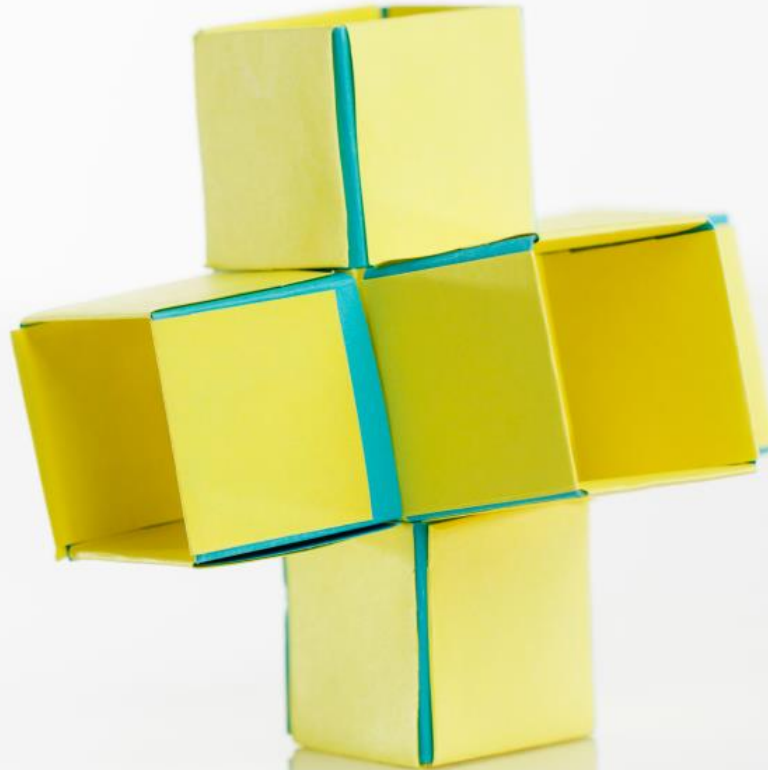


Meta-biomaterials

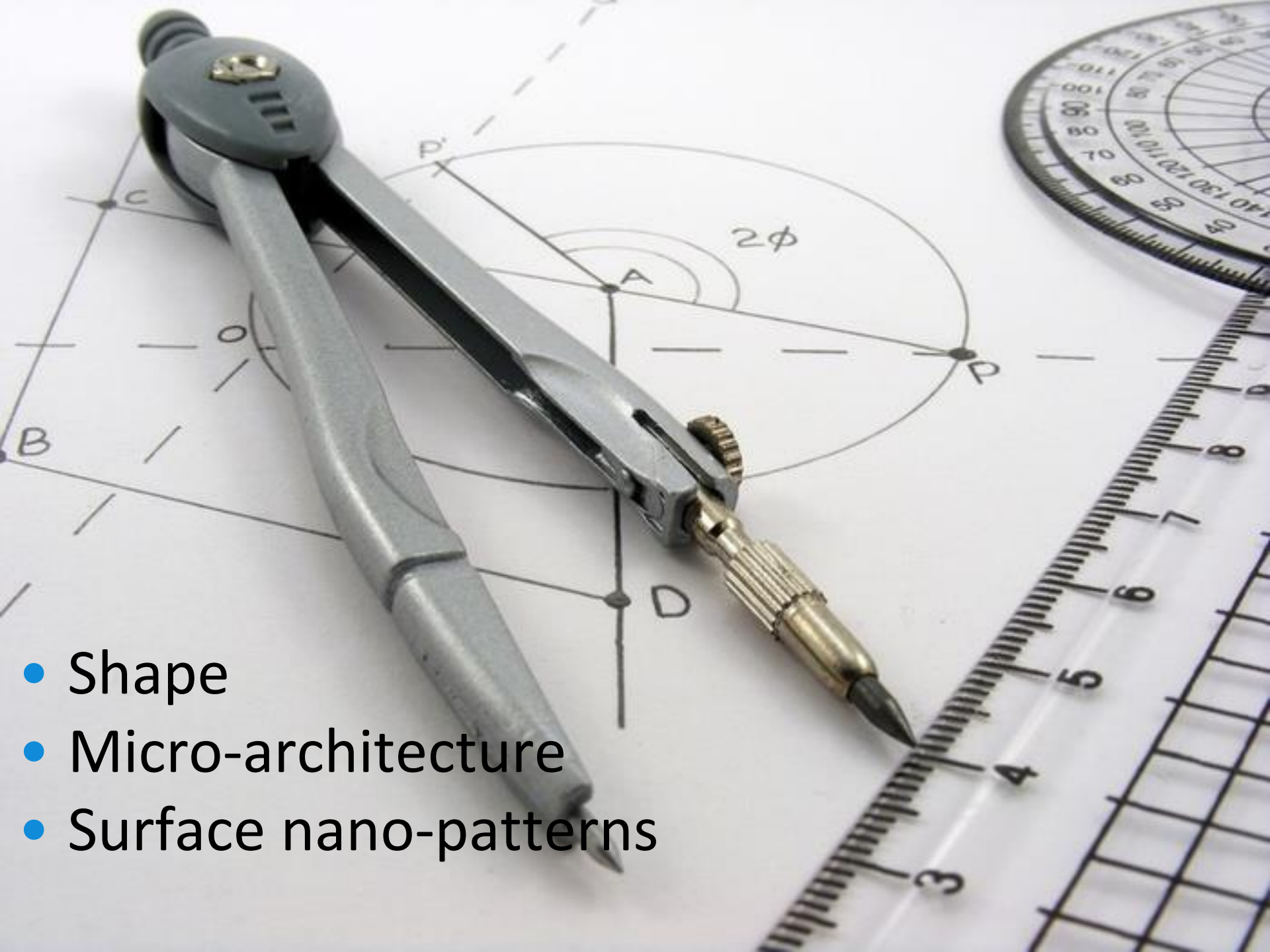


Prof. dr. Amir A. Zadpoor

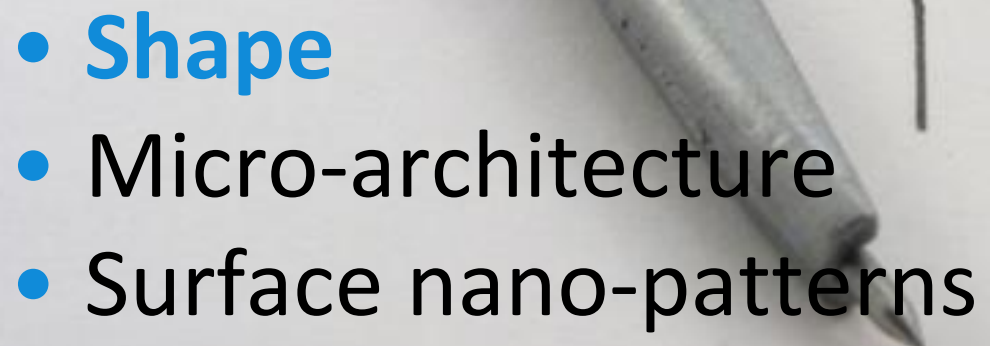
Antoni van Leeuwenhoek Distinguished Professor
Chaired Professor of Biomaterials & Tissue Biomechanics

Patient



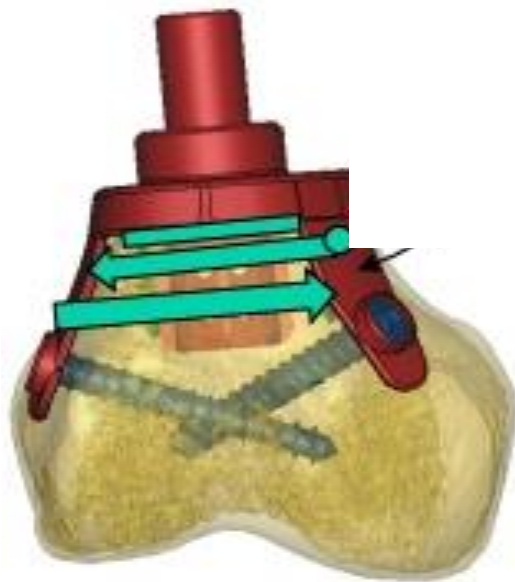


- Shape
- Micro-architecture
- Surface nano-patterns



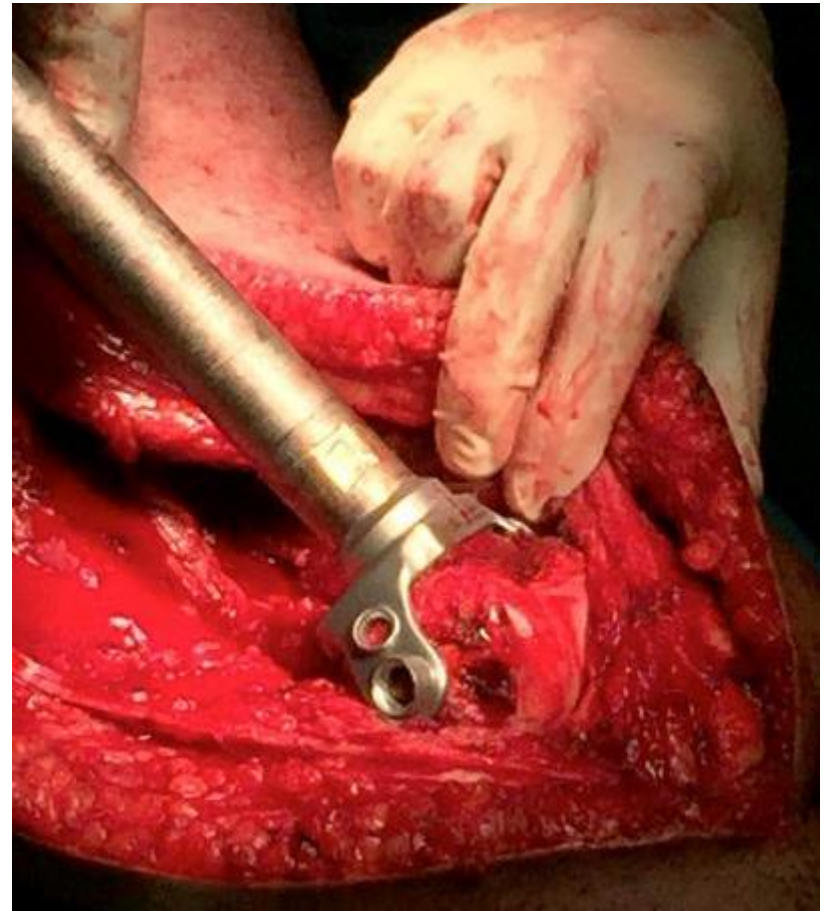
- Shape
- Micro-architecture
- Surface nano-patterns

Patient-specific implants



ic
implantcast

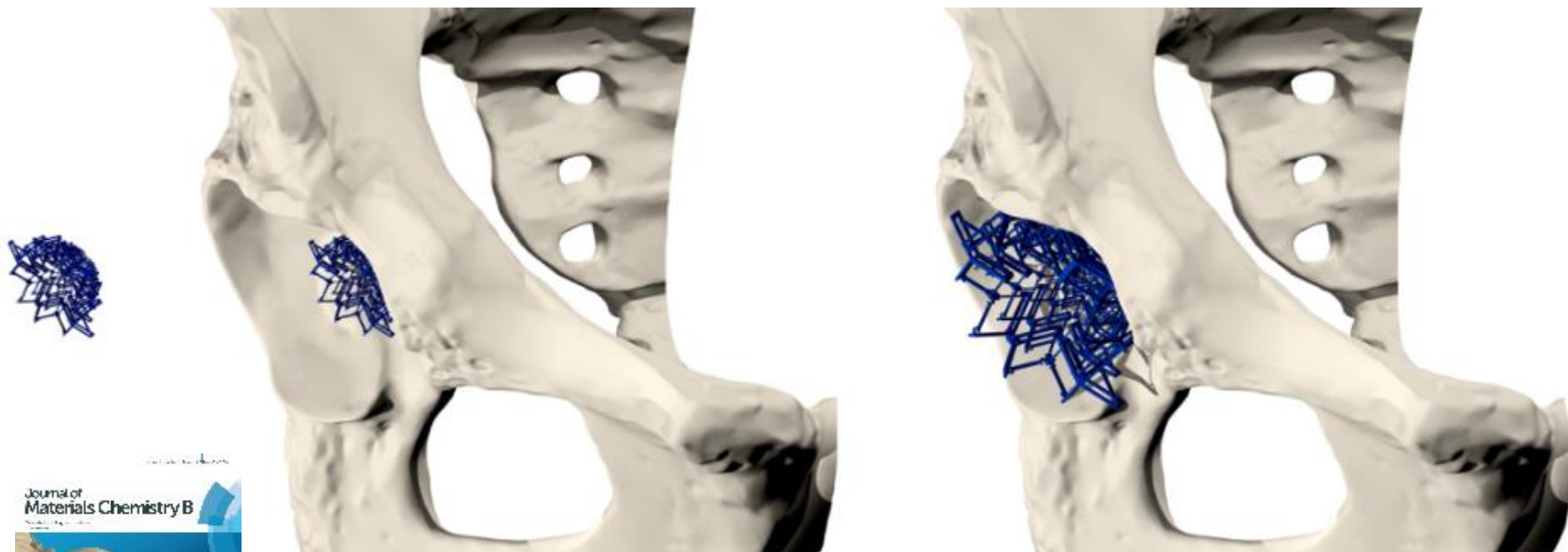
LU
MC







Deployable meta-implants



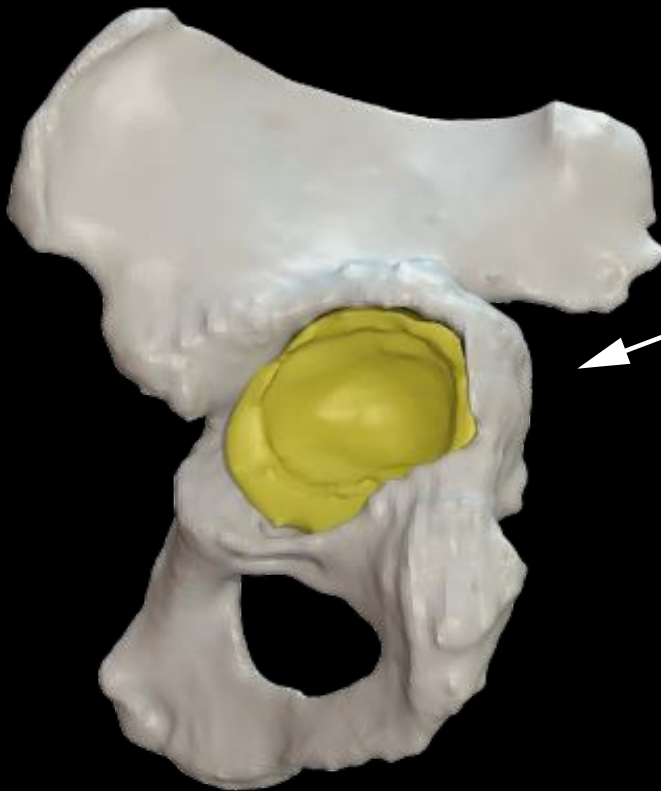
J Mater Chem B, 2018



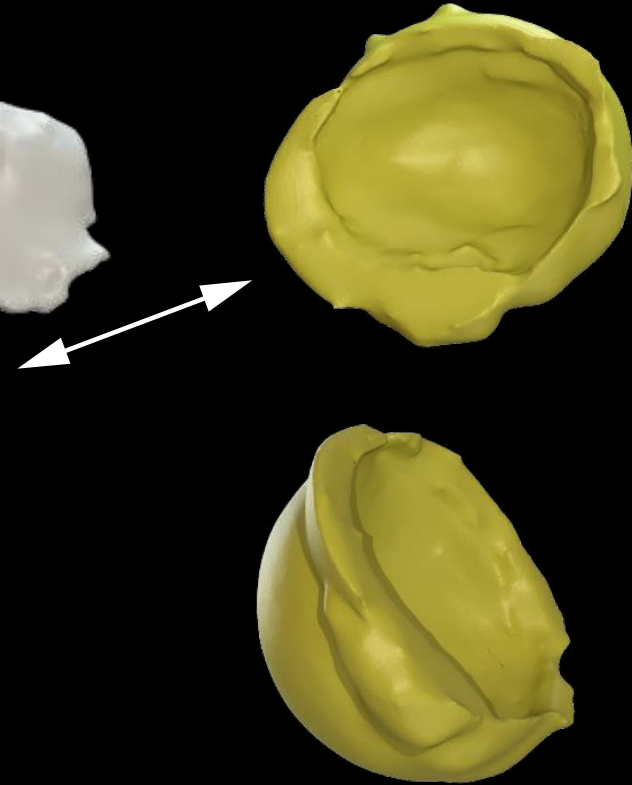
Metallic clay



**Shape-defining
boundaries**

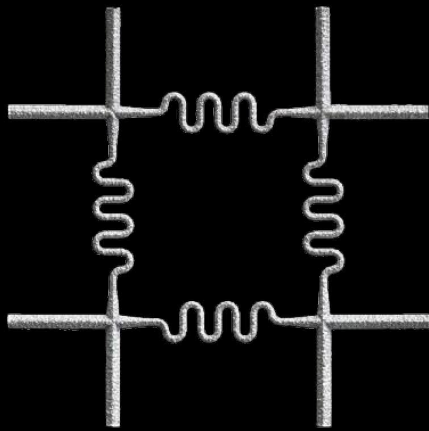


**Shape-morphing
clay**

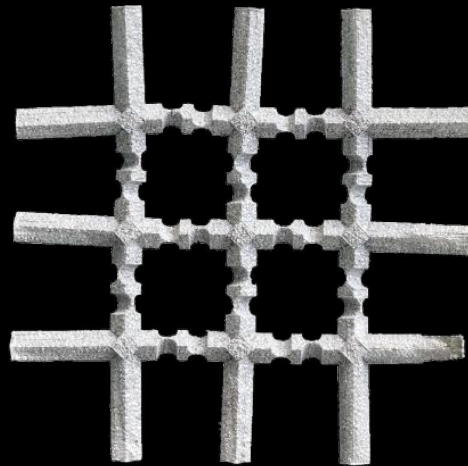


**Locked shape of
the clay**

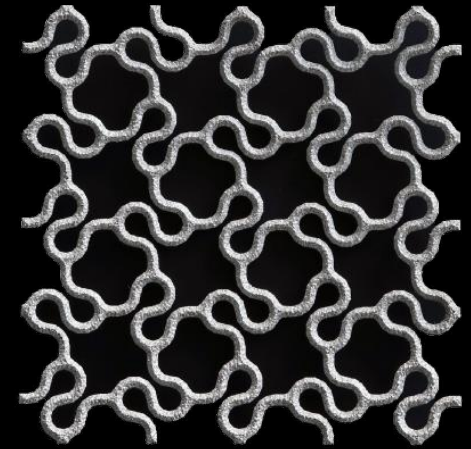
Compliant joints



20 mm

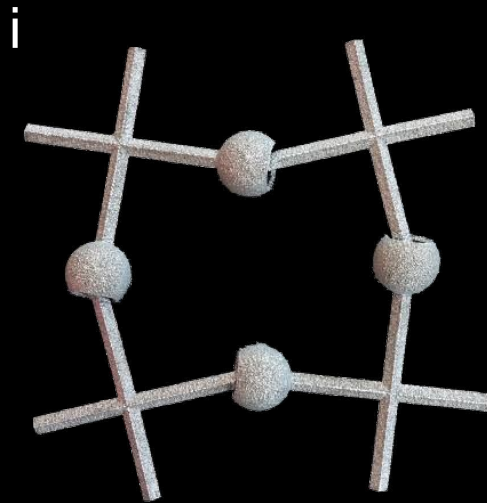


20 mm

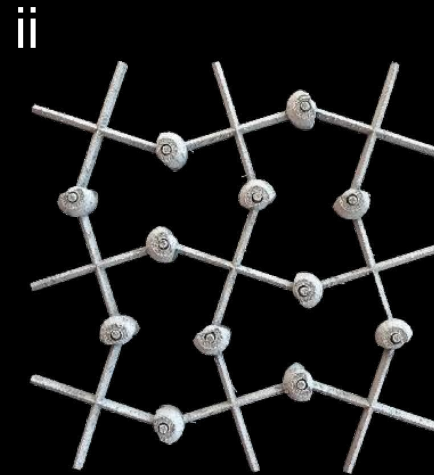


20 mm

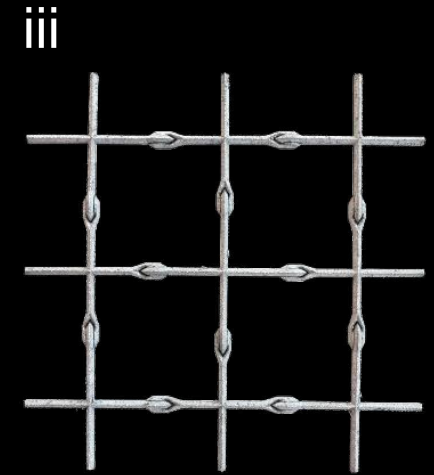
Kinematic joints



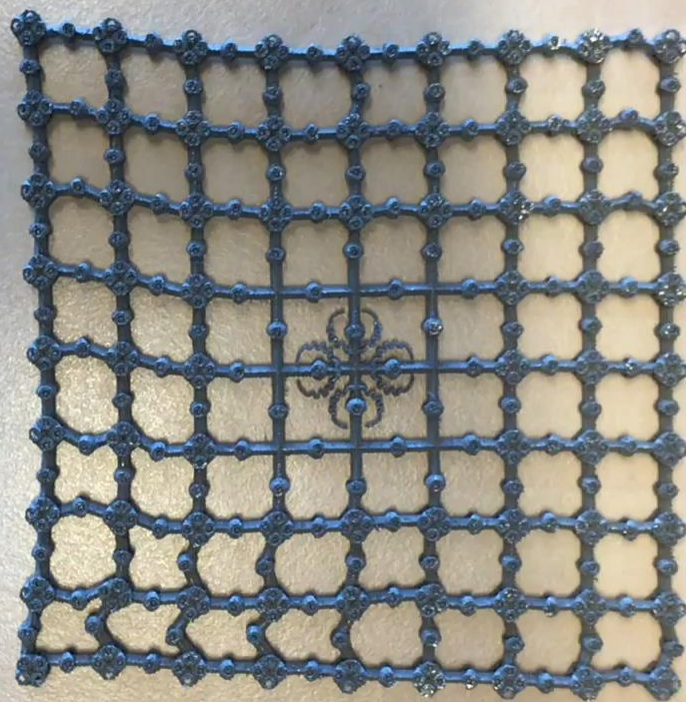
25 mm



20 mm

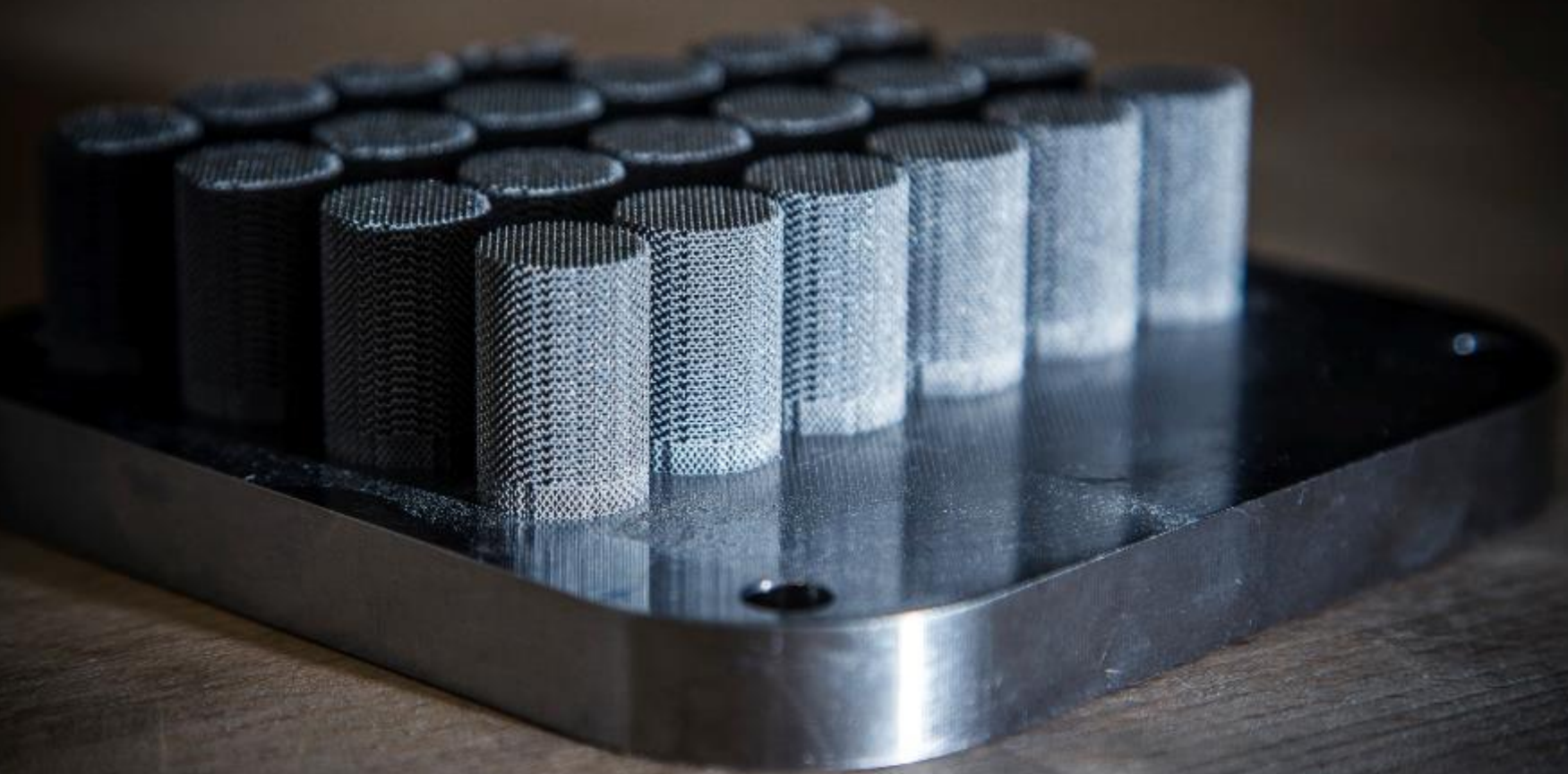


20 mm

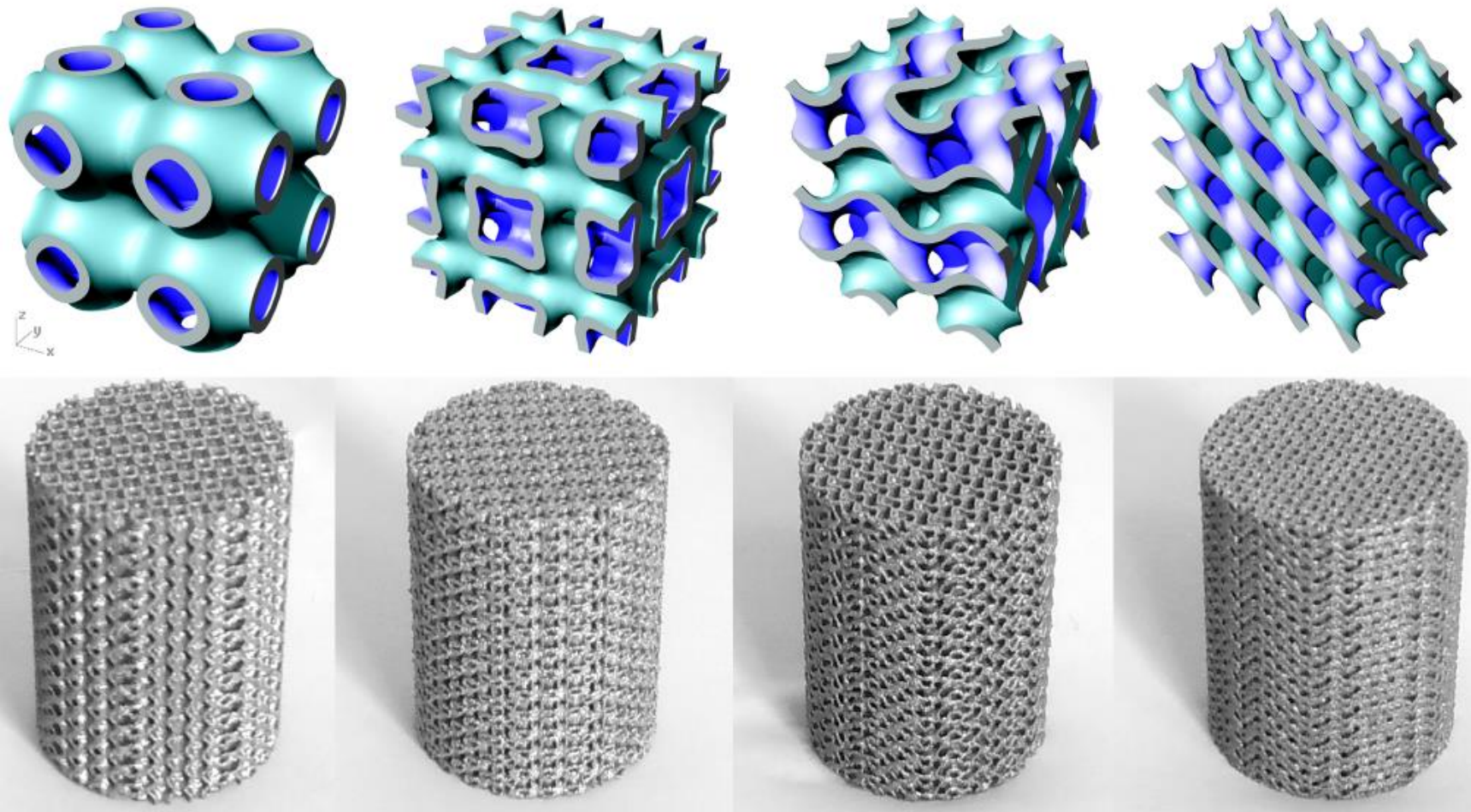




- Shape
- **Micro-architecture**
- Surface nano-patterns

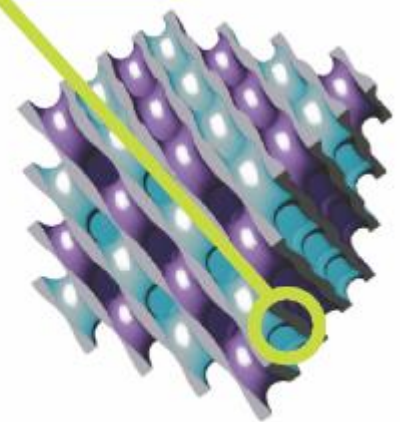
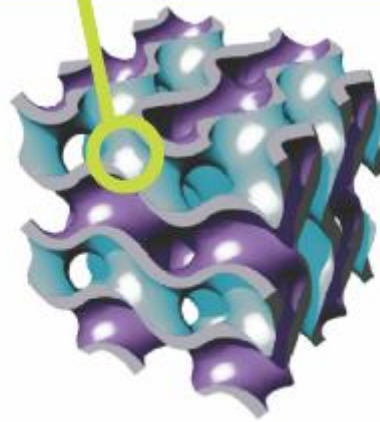
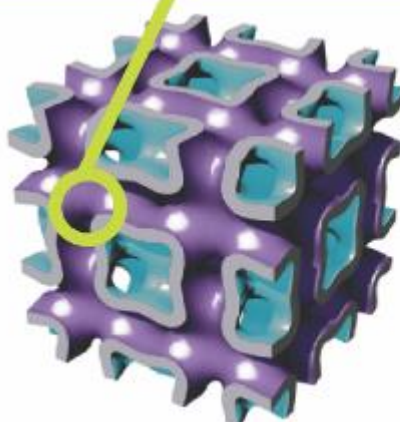
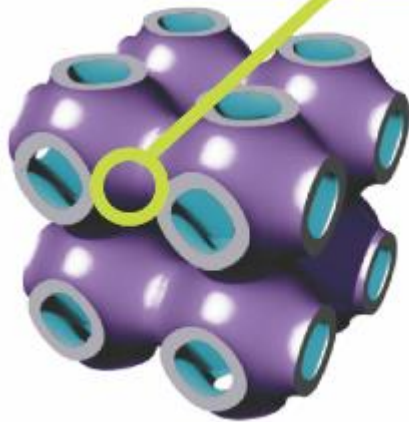


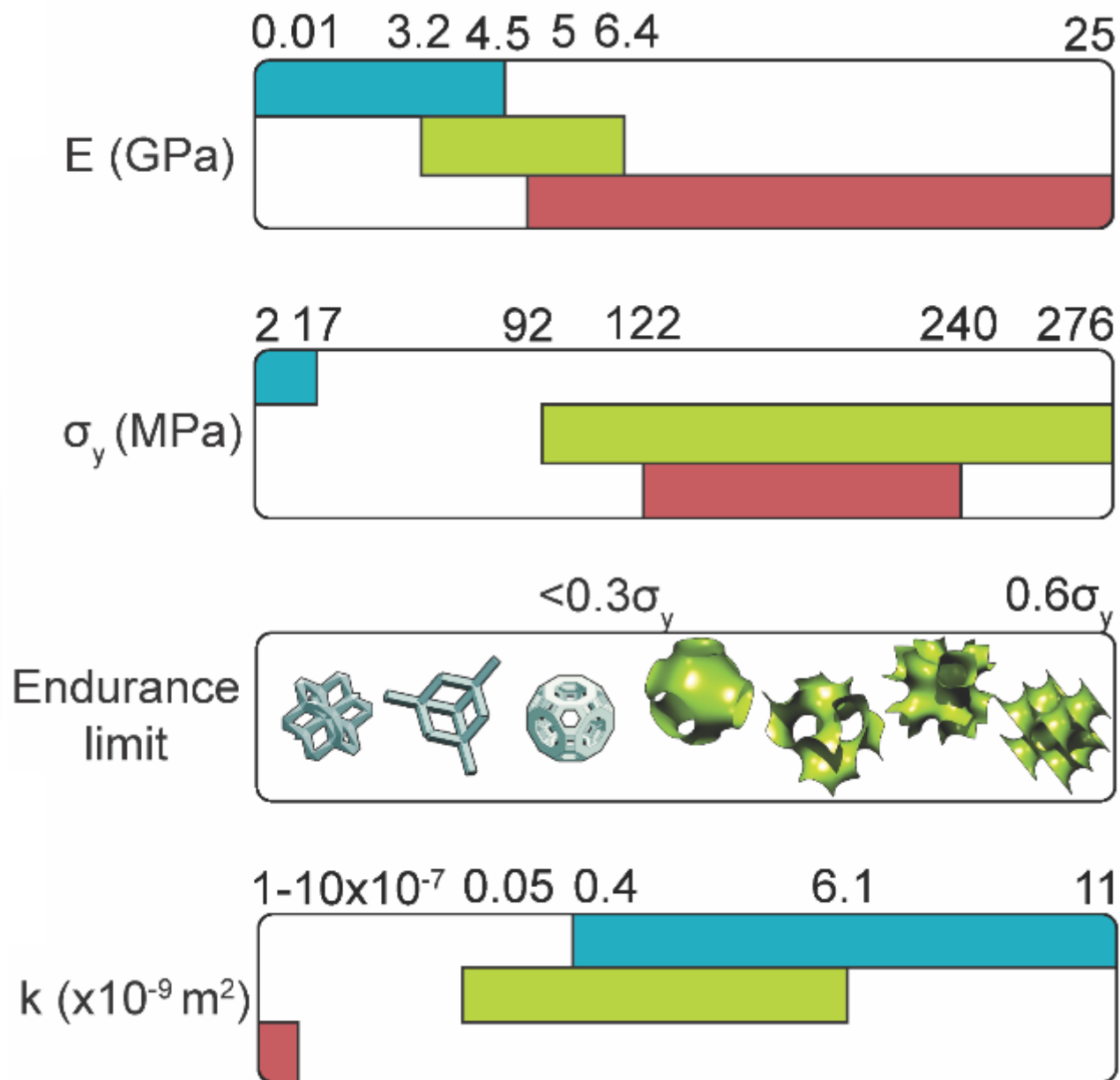
Triply periodic minimal surfaces

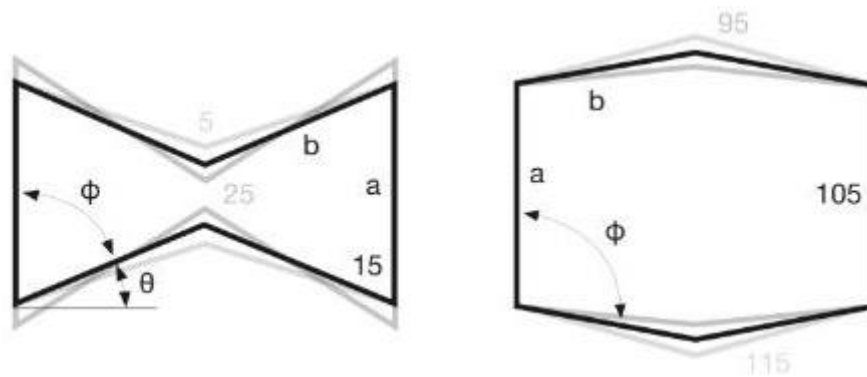




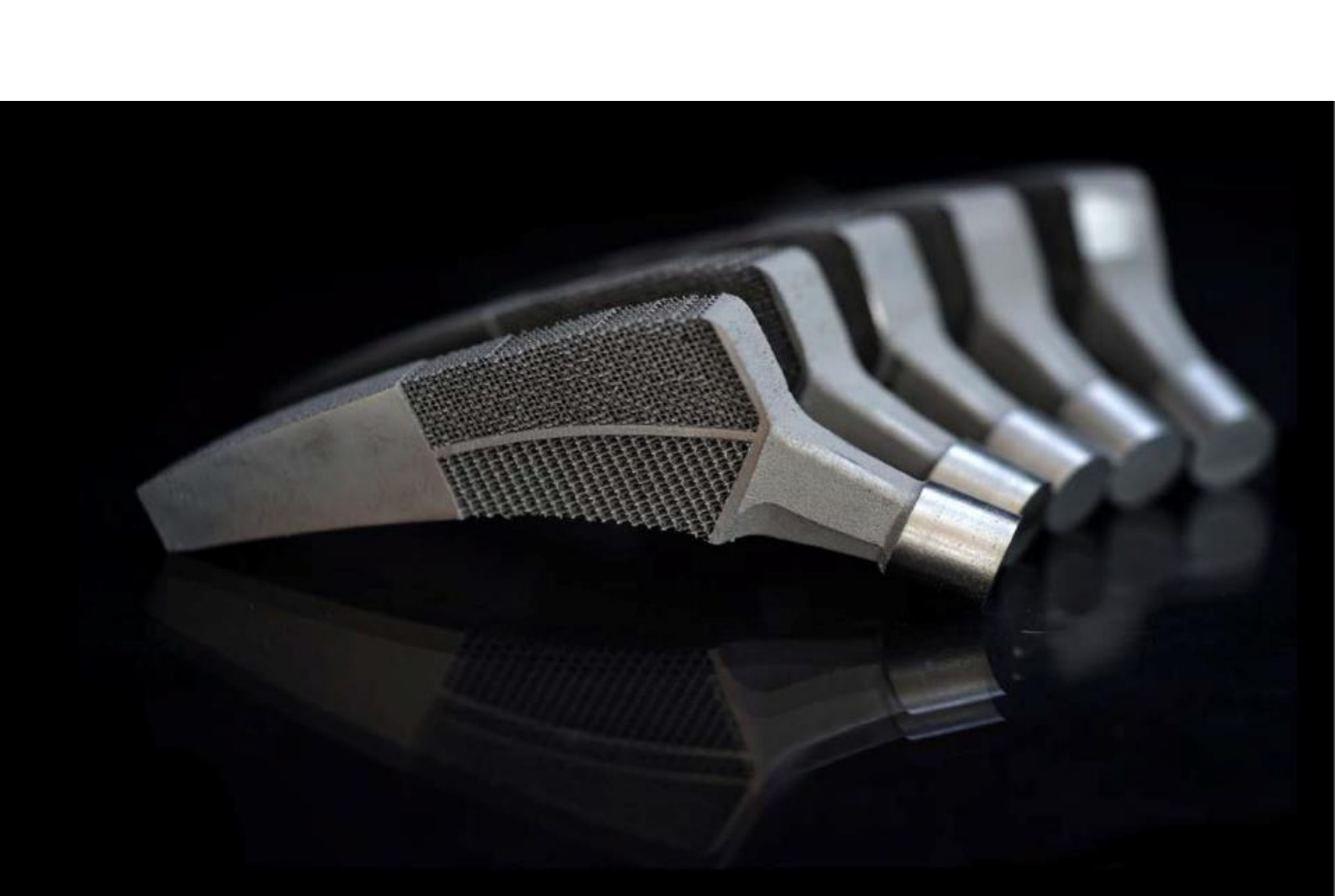
Mean surface curvature of zero



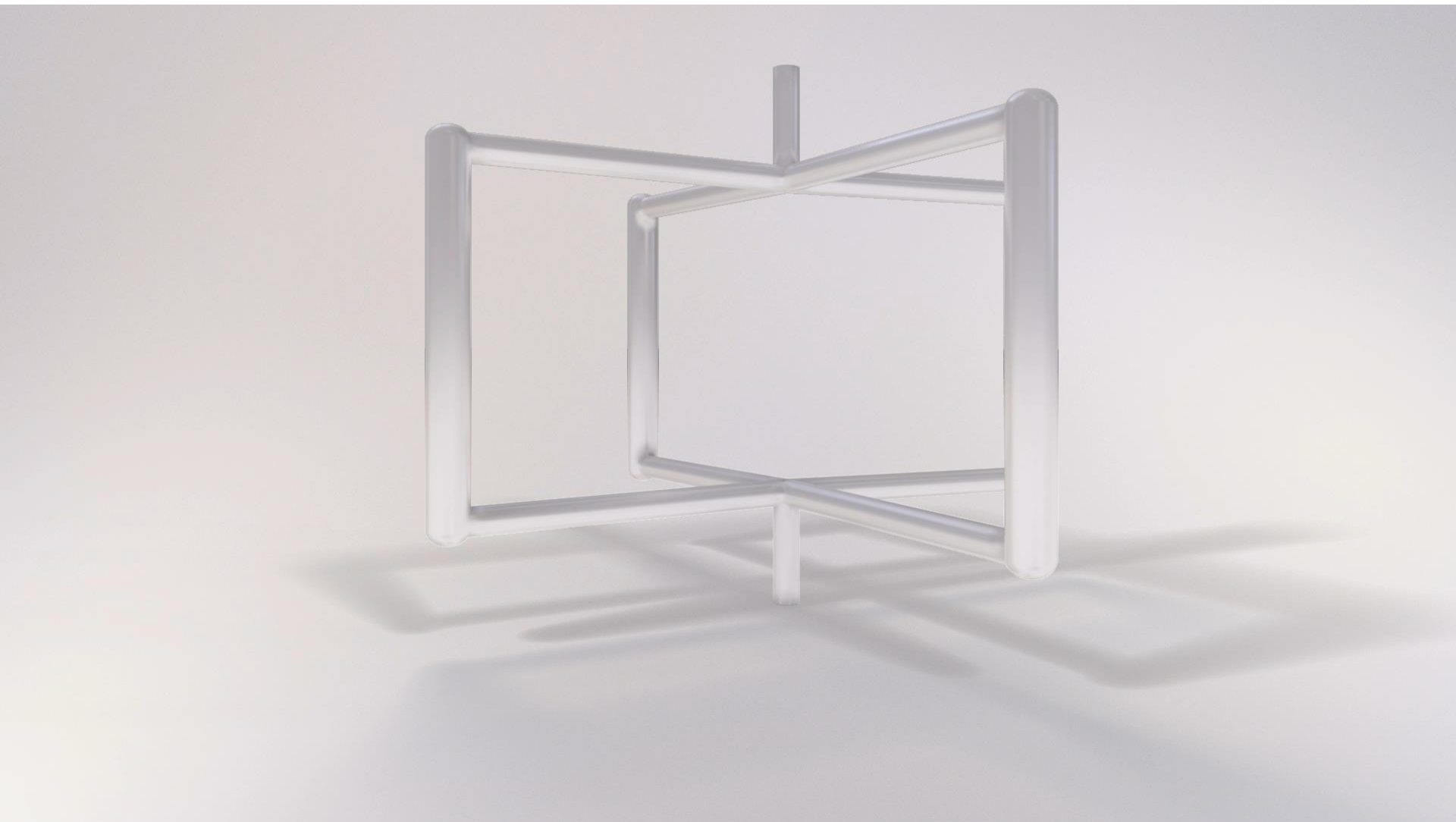




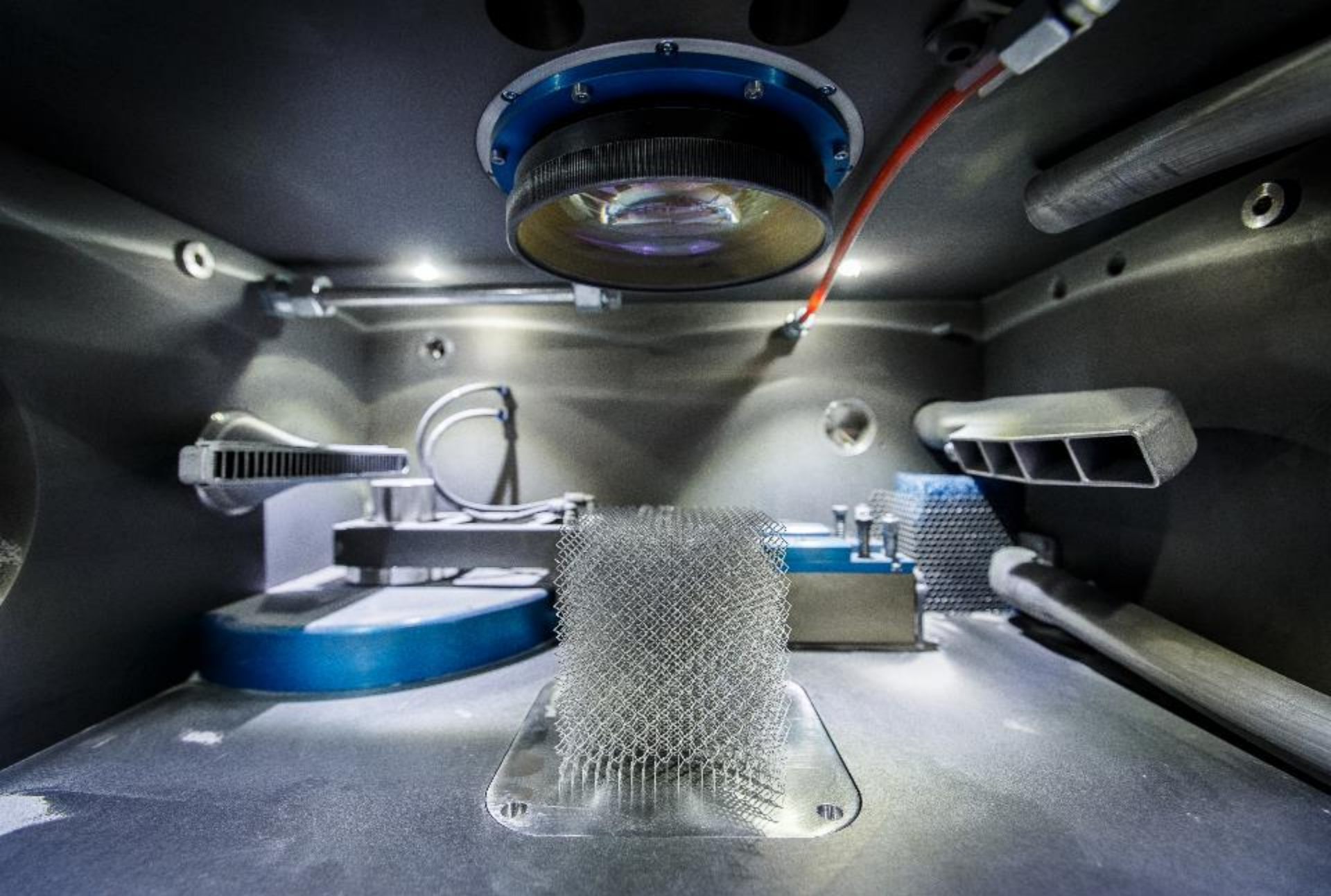
Materials Horizons, 2018

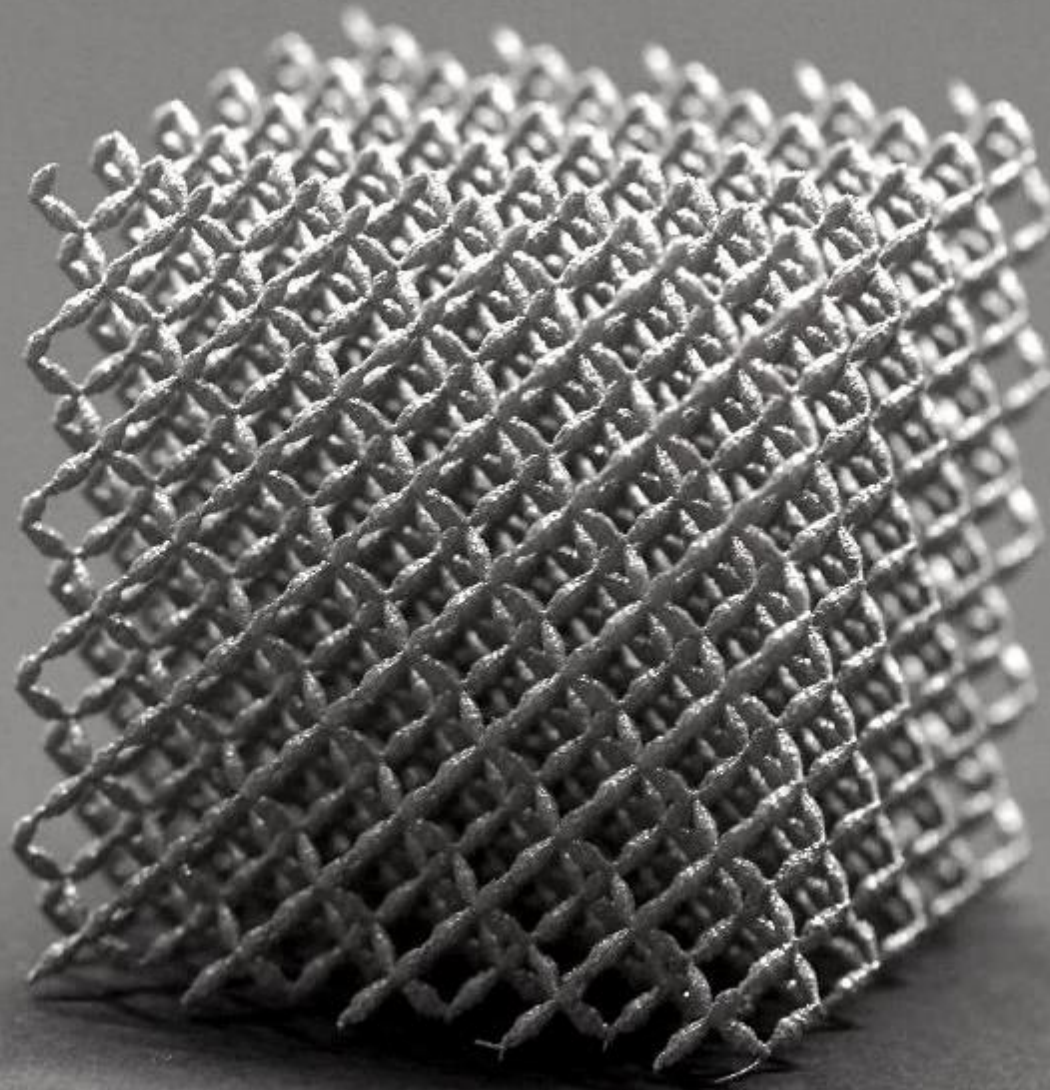


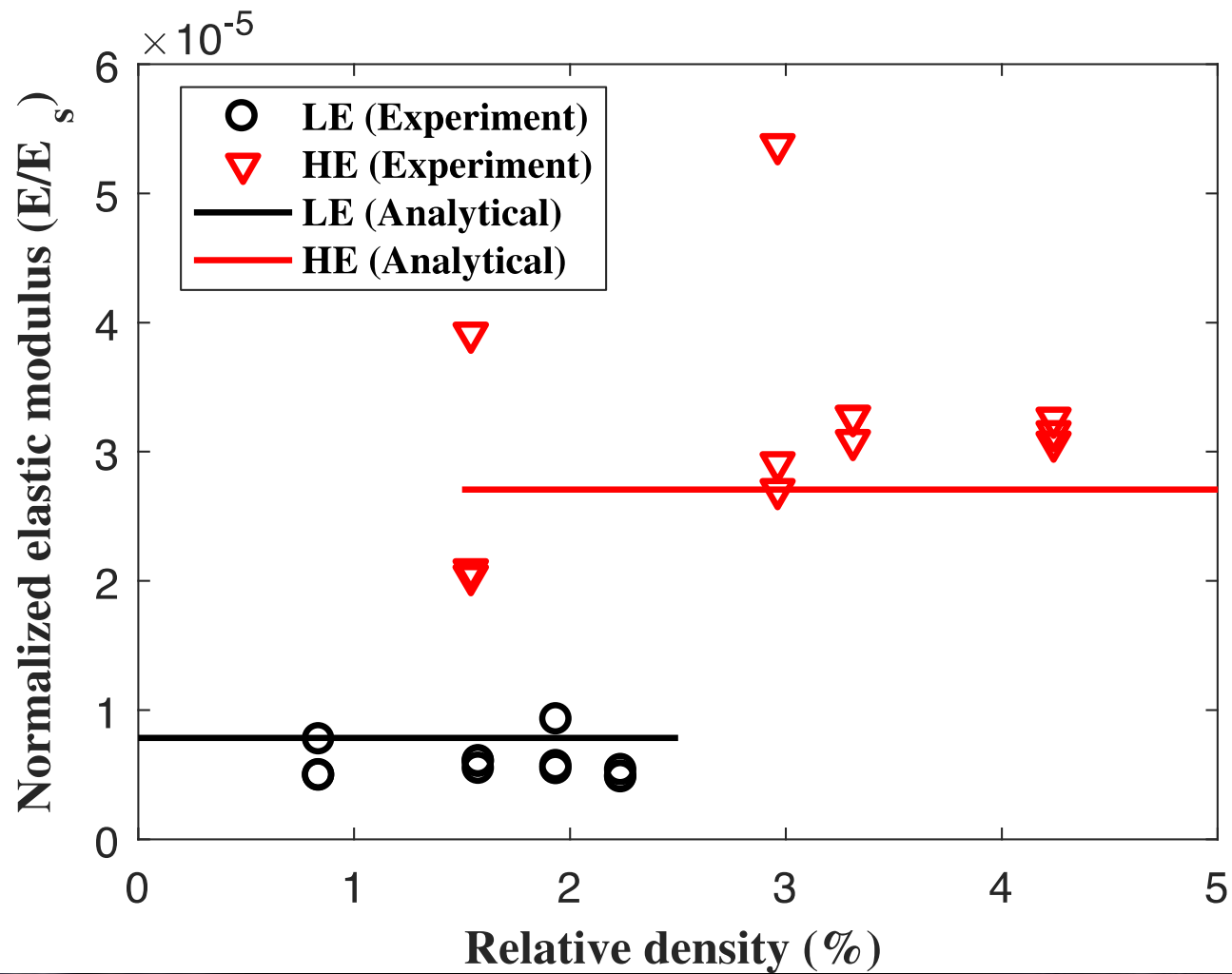
Materials Horizons, 2018



Materials Horizons, 2018



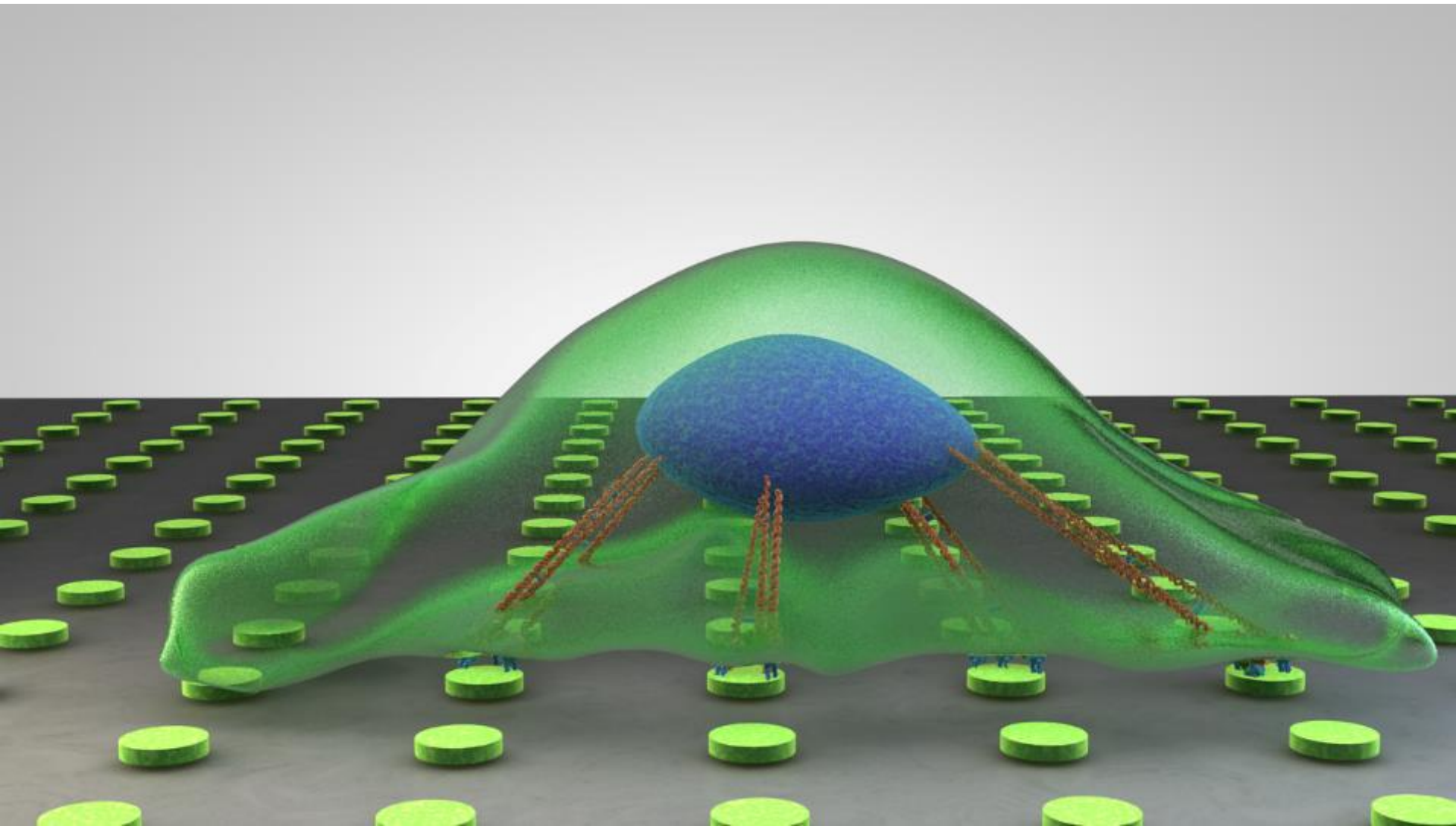




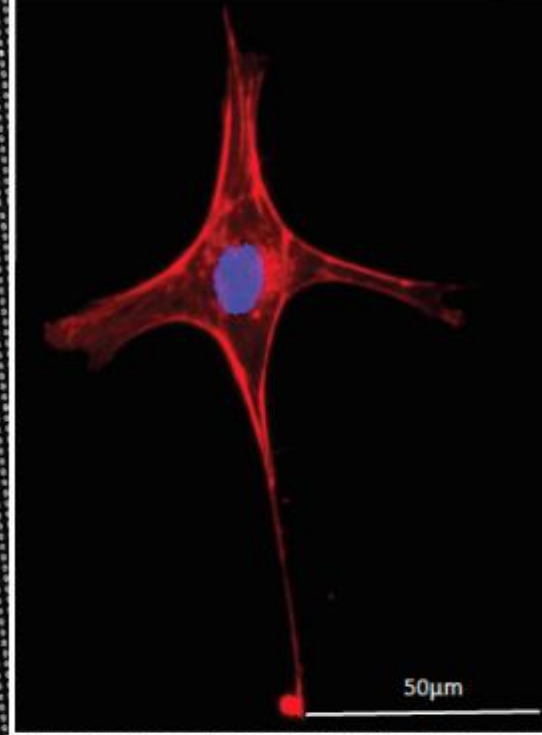
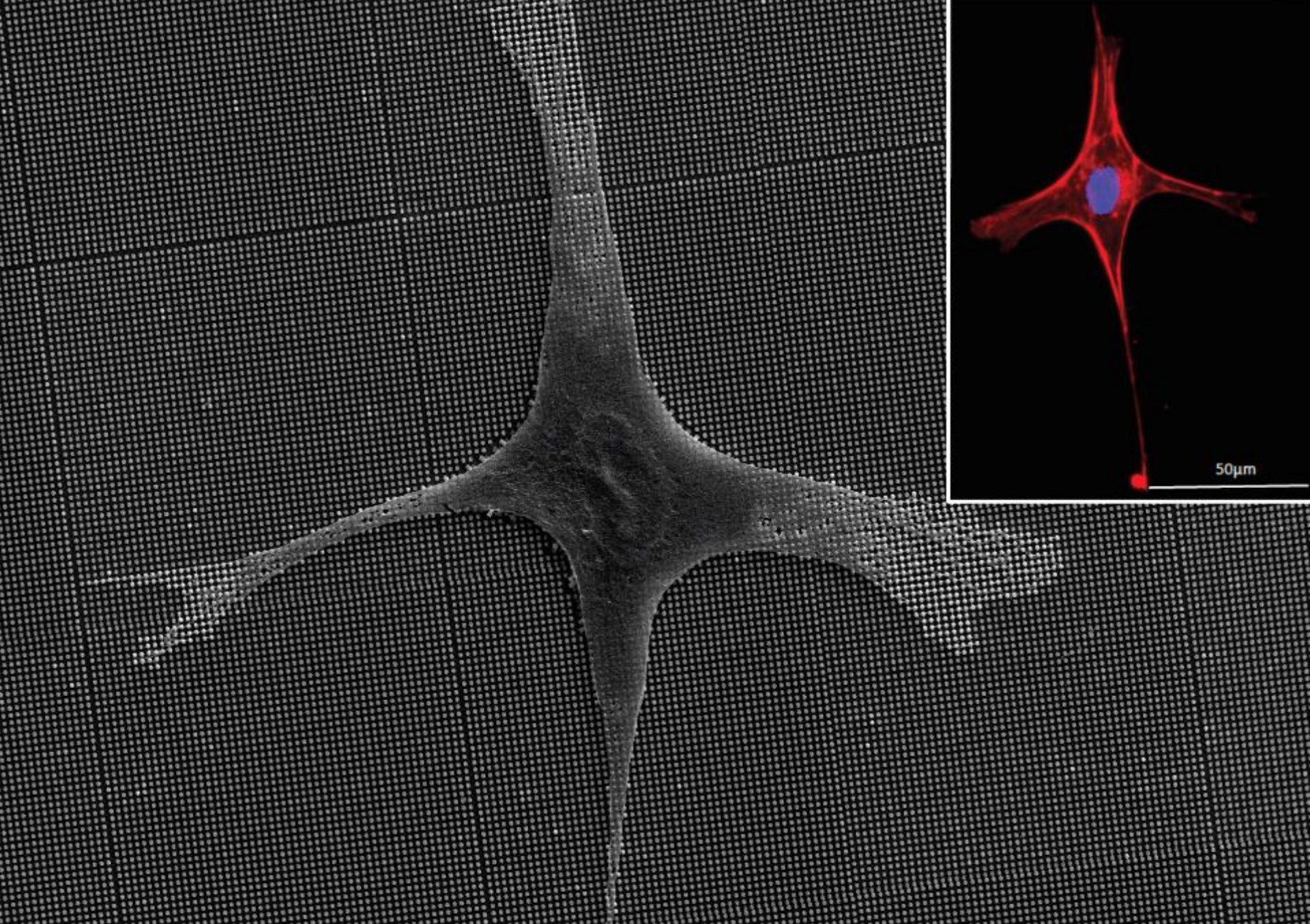




- Shape
- Micro-architecture
- **Surface nano-patterns**

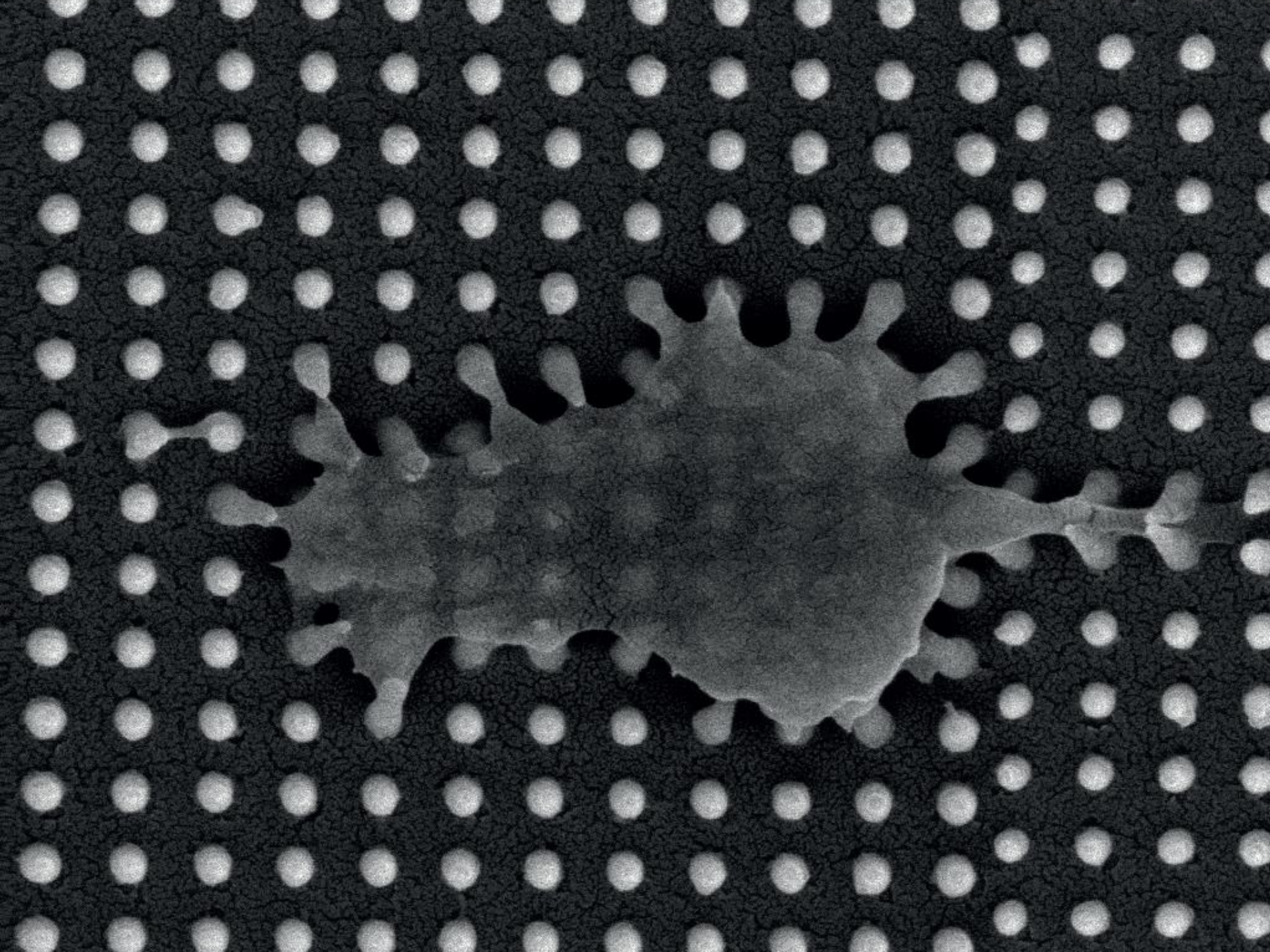


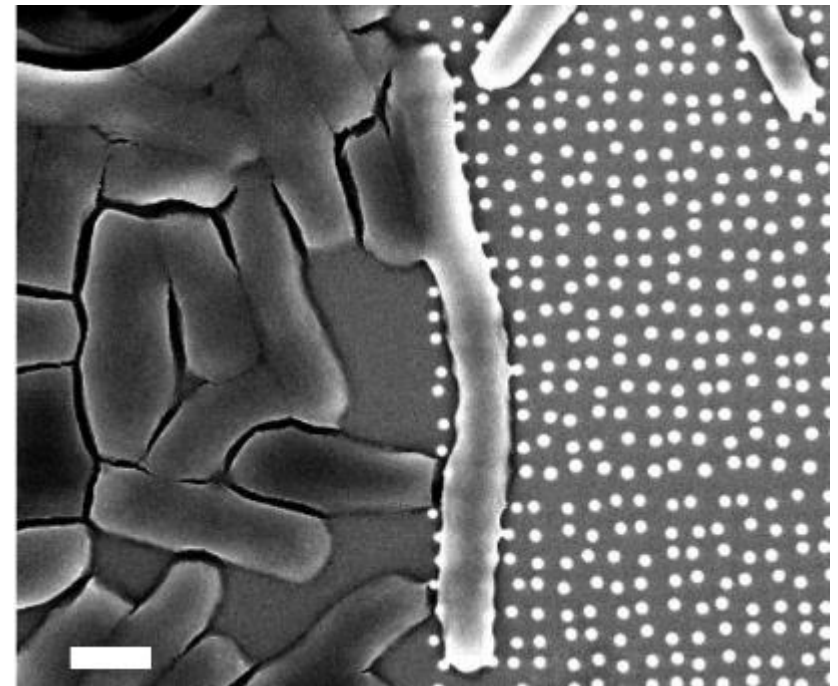
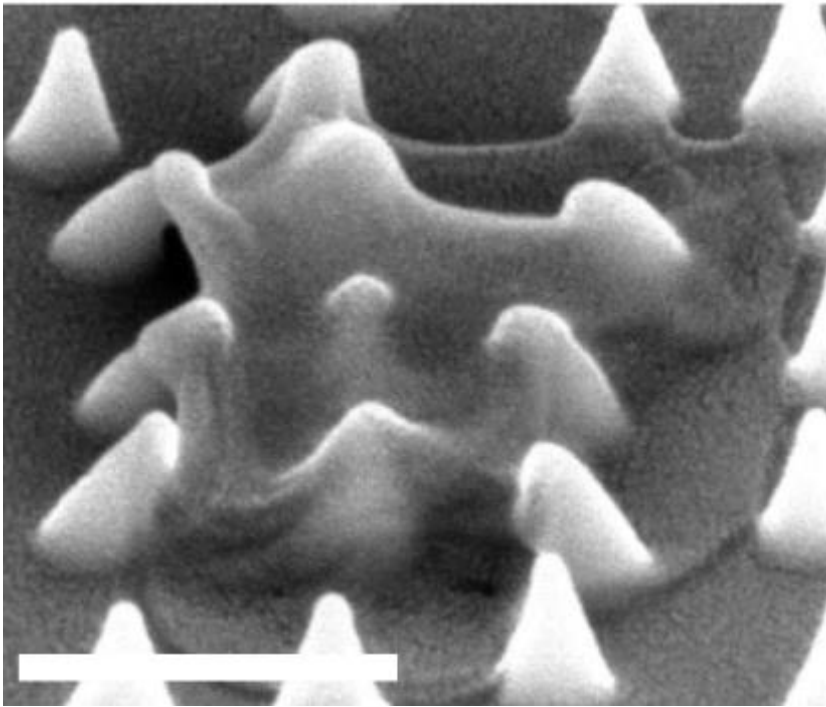
Acta Biomater, 2016



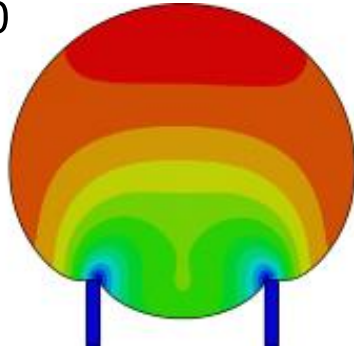
3/11/2019 dwell HV HFW
2:58:55 PM 45.00 μs 10.00 kV 138 μm

50 μm
Helios

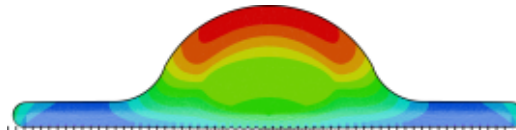
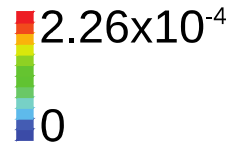




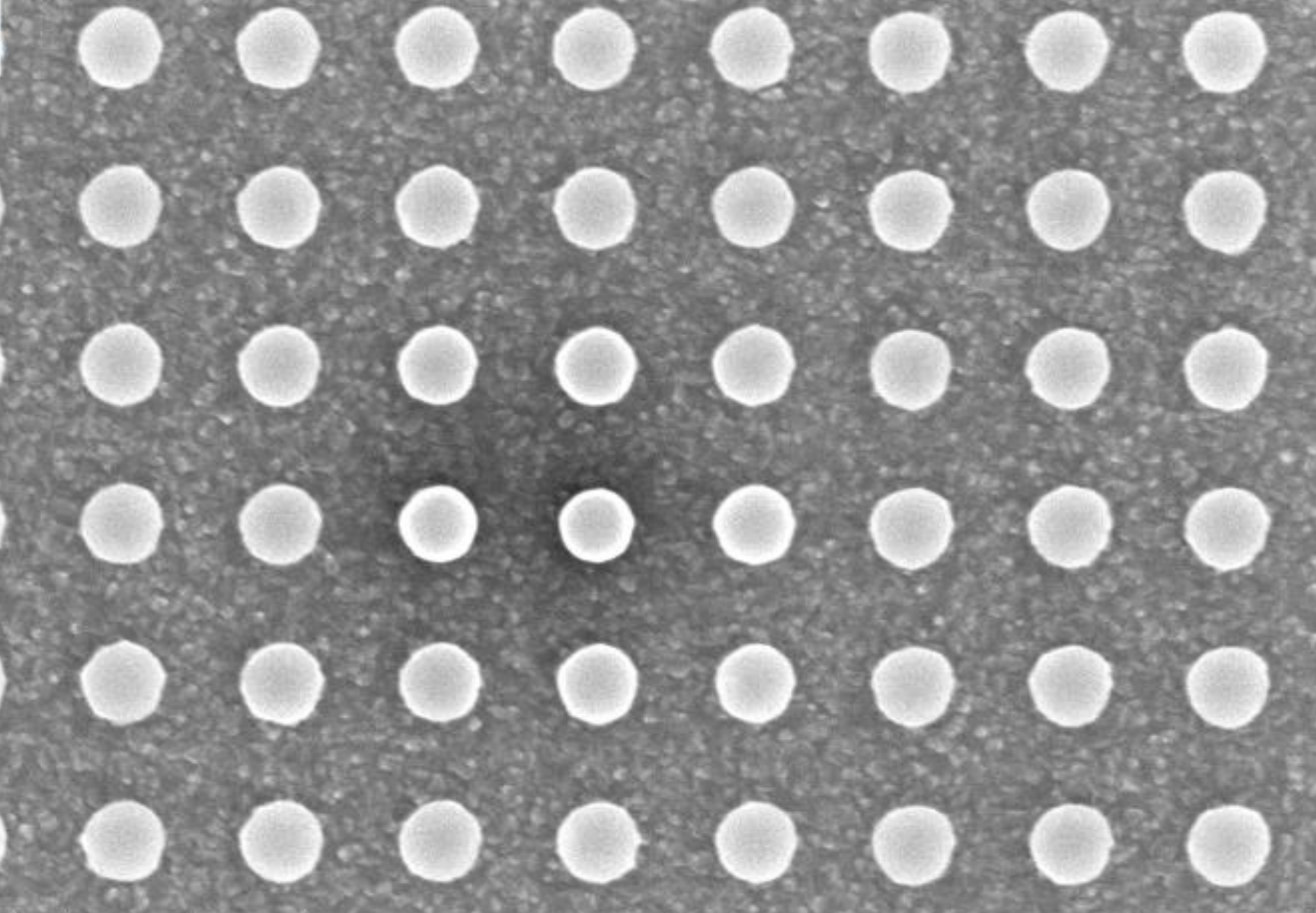
Staphylococcus aureus



Osteoblast cell



Normalized interspace	Interspace [nm]	Width [nm]			
		25	50	120	200
0.5	300				
0.167	100				
0.067	40				
		Normalized width			
		0.042	0.083	0.200	0.333



3/11/2016
11:45:34 AM

HV
5.00 kV

HPW
3.45 μm

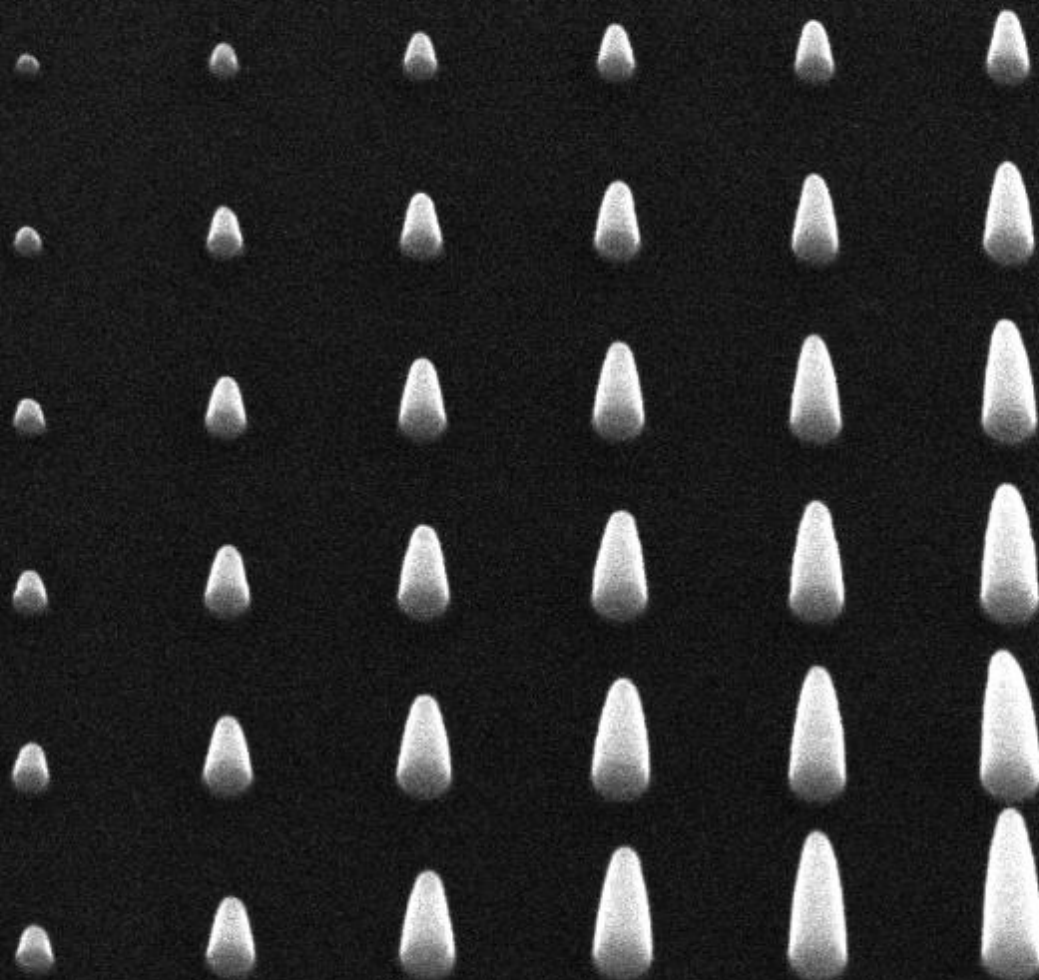
WD
5.0 mm

det
TLD

tilt
0 °

1 μm

Nova NanoSEM



WD
5.3 mm

1/8/2016
5:33:37 PM

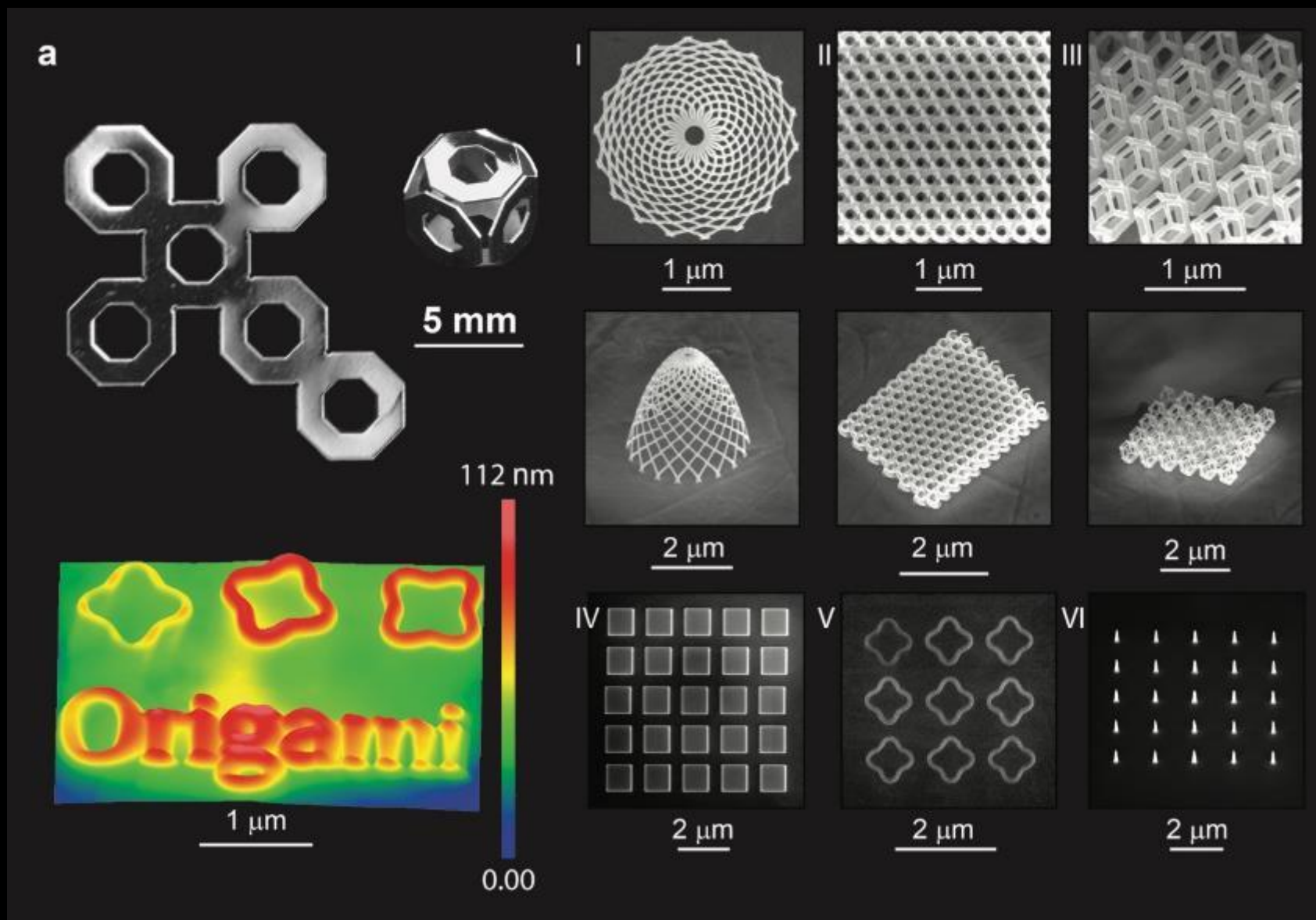
curr
39 pA

HV
19.50 kV

tilt
25 °

500 nm

Varying dwelling time and passings to pro



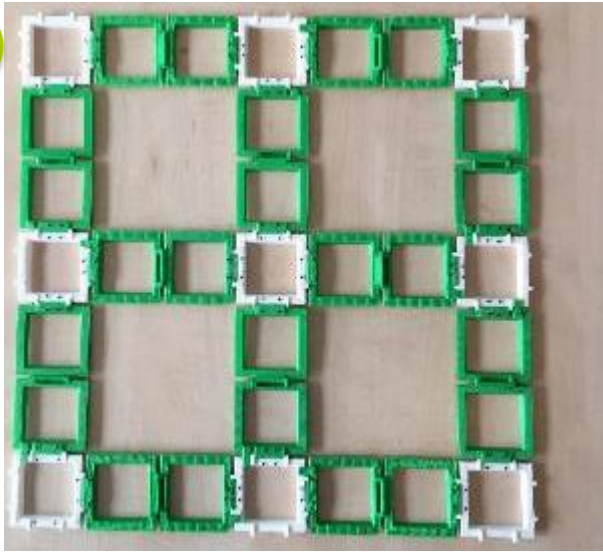
Bio-origami



European Research Council
Established by the European Commission

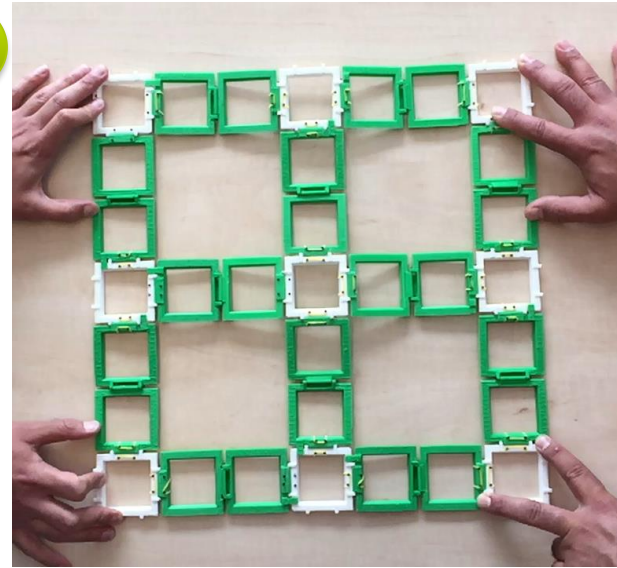


1



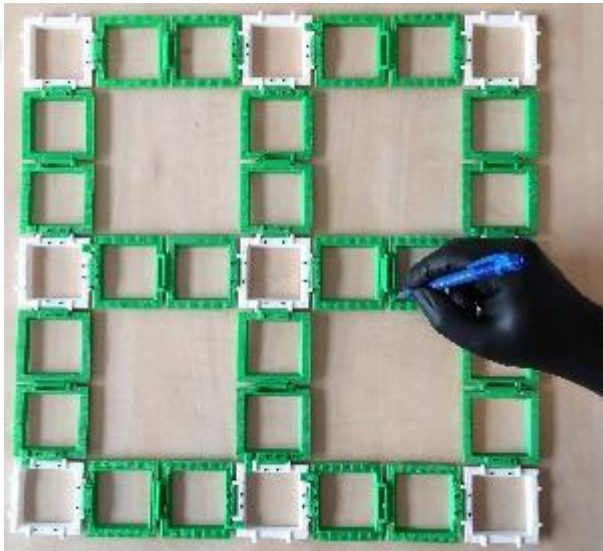
Flat structure

3



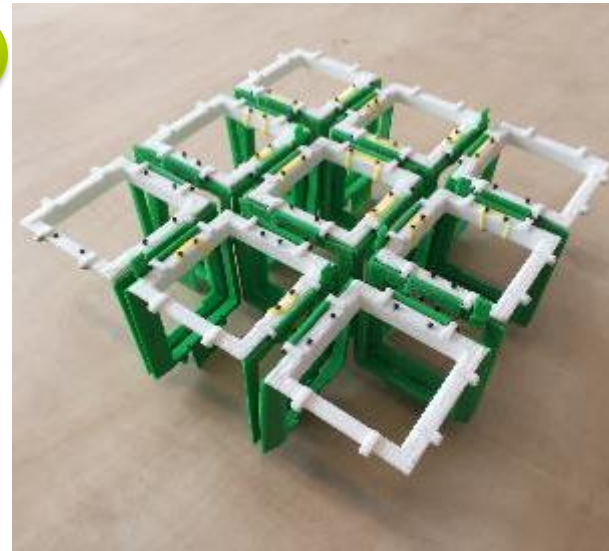
Self-folding

2

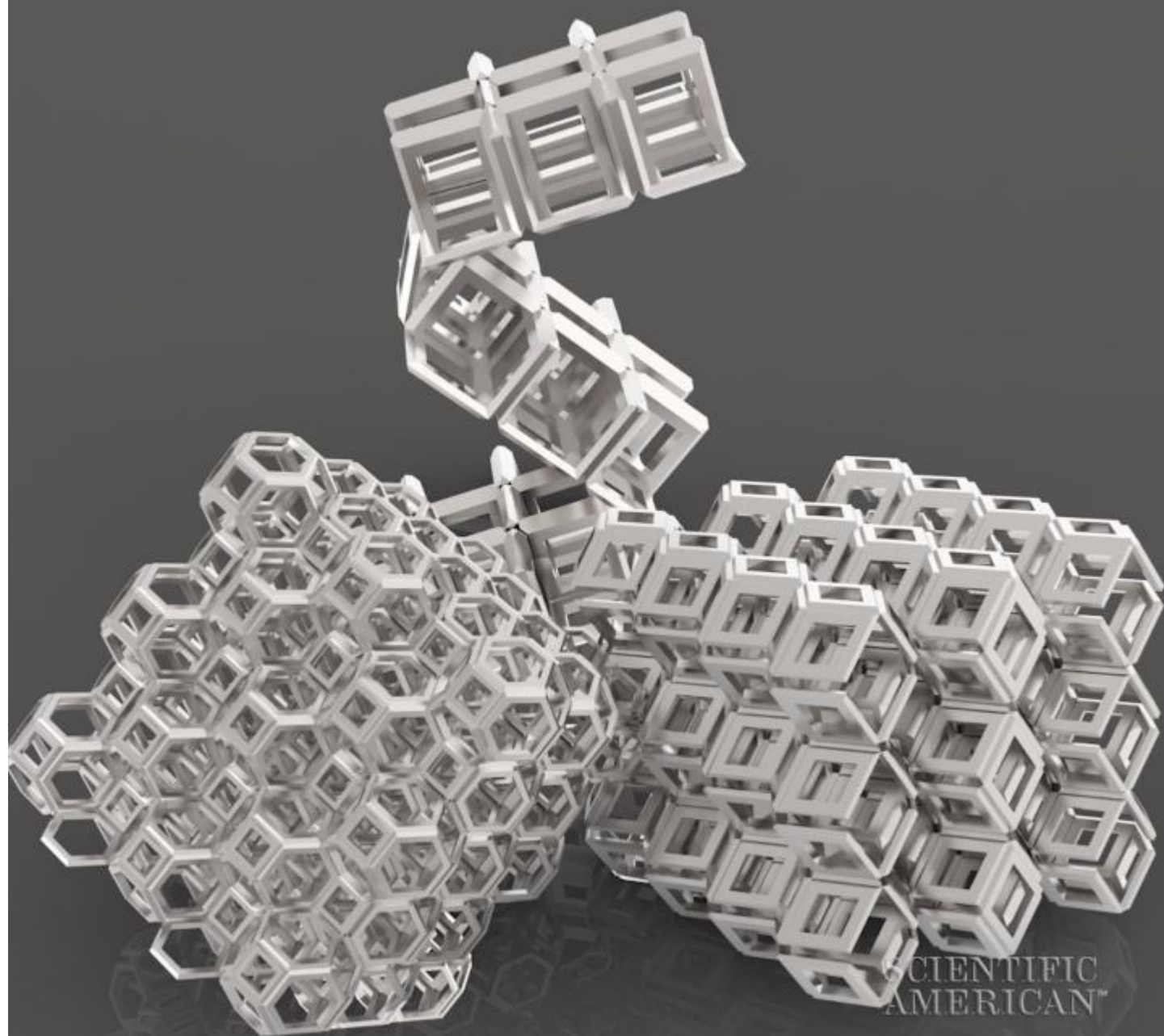


Surface nano-patterning

4



Bio-origami



SCIENTIFIC
AMERICAN™



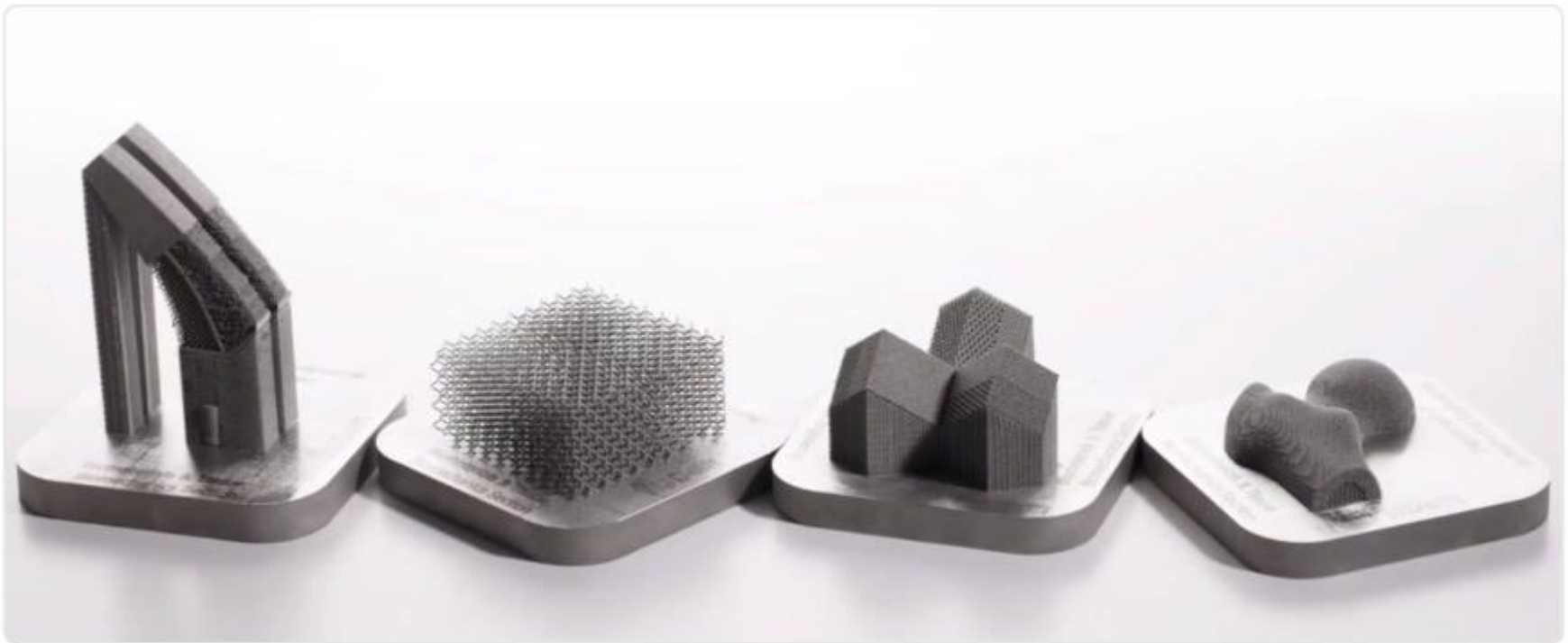
Science Magazine ✓

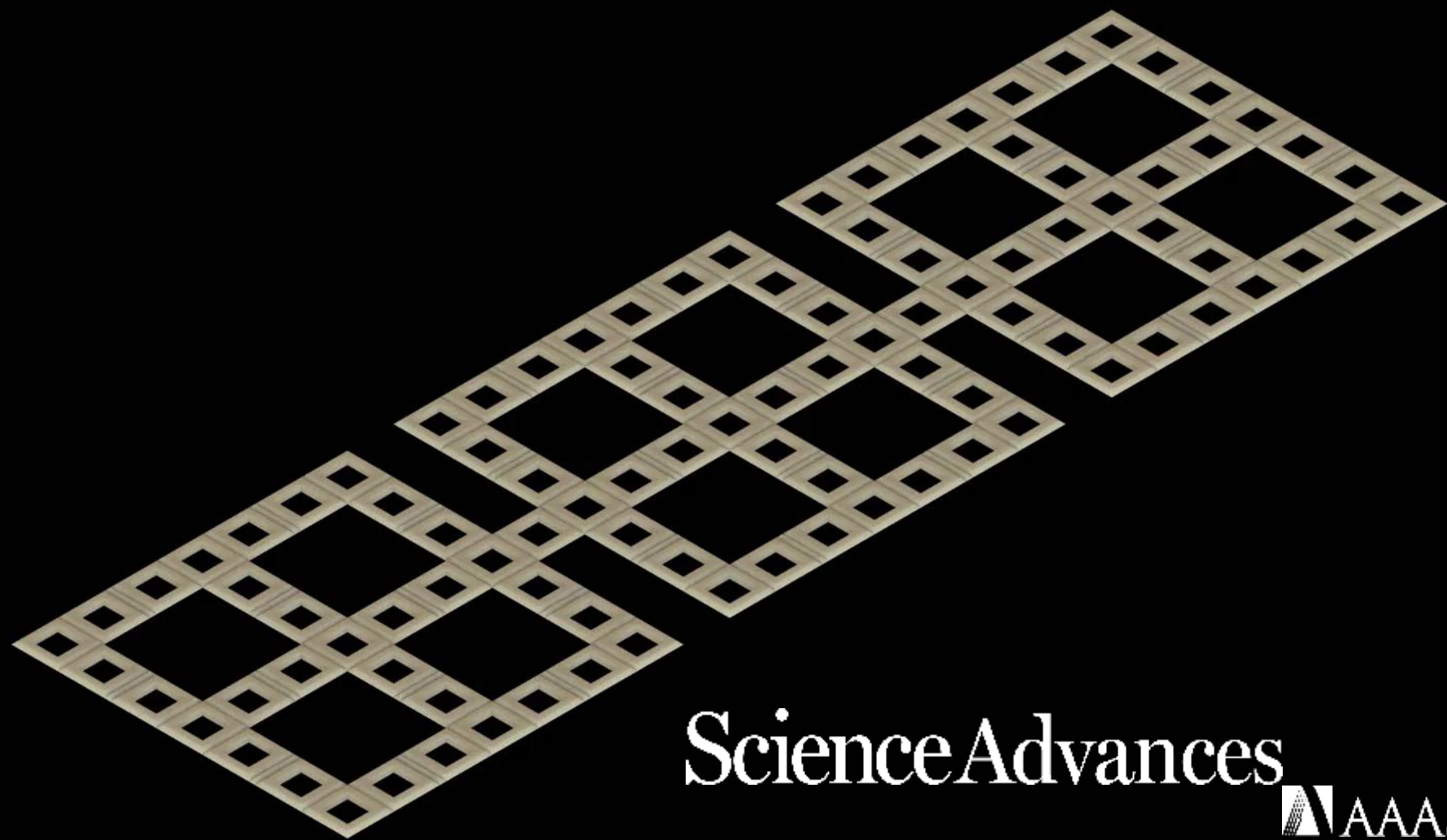
@sciencemagazine

Follow



New designs for self-folding scaffolds in [@ScienceAdvances](#) could extend the functions of printed lattice structures: scim.ag/2j3efV8

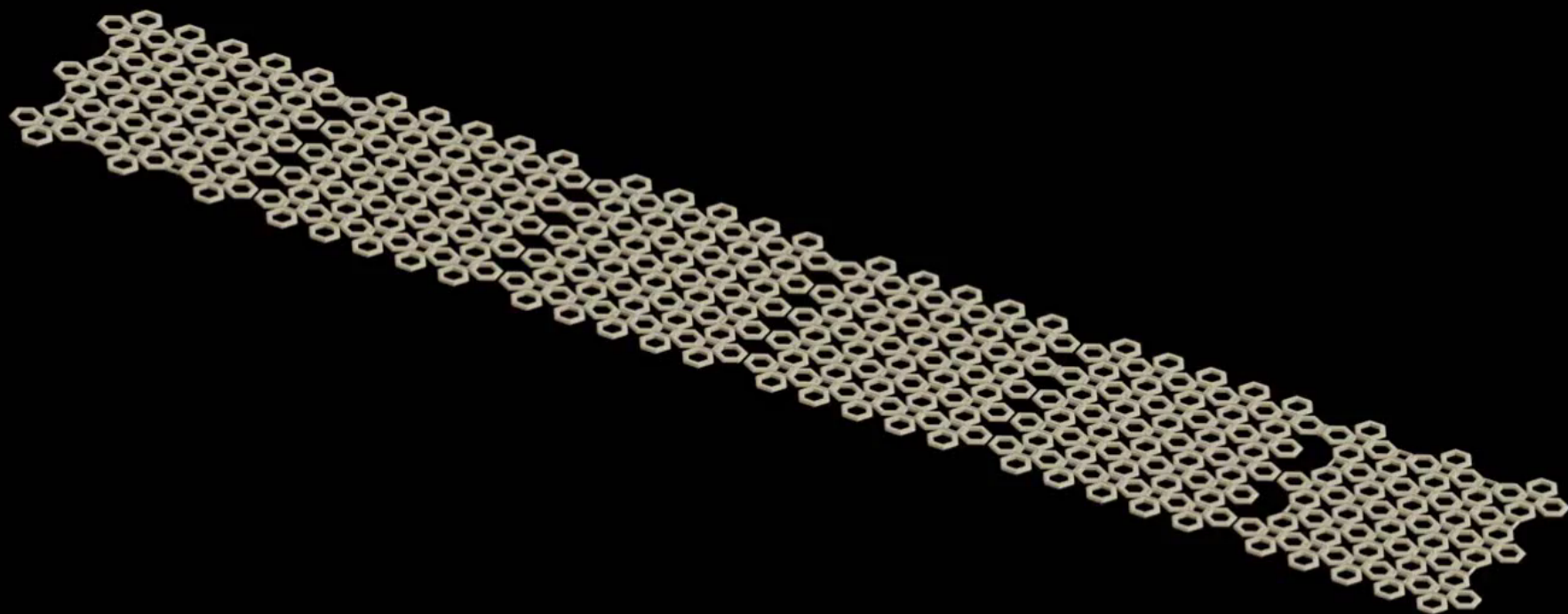




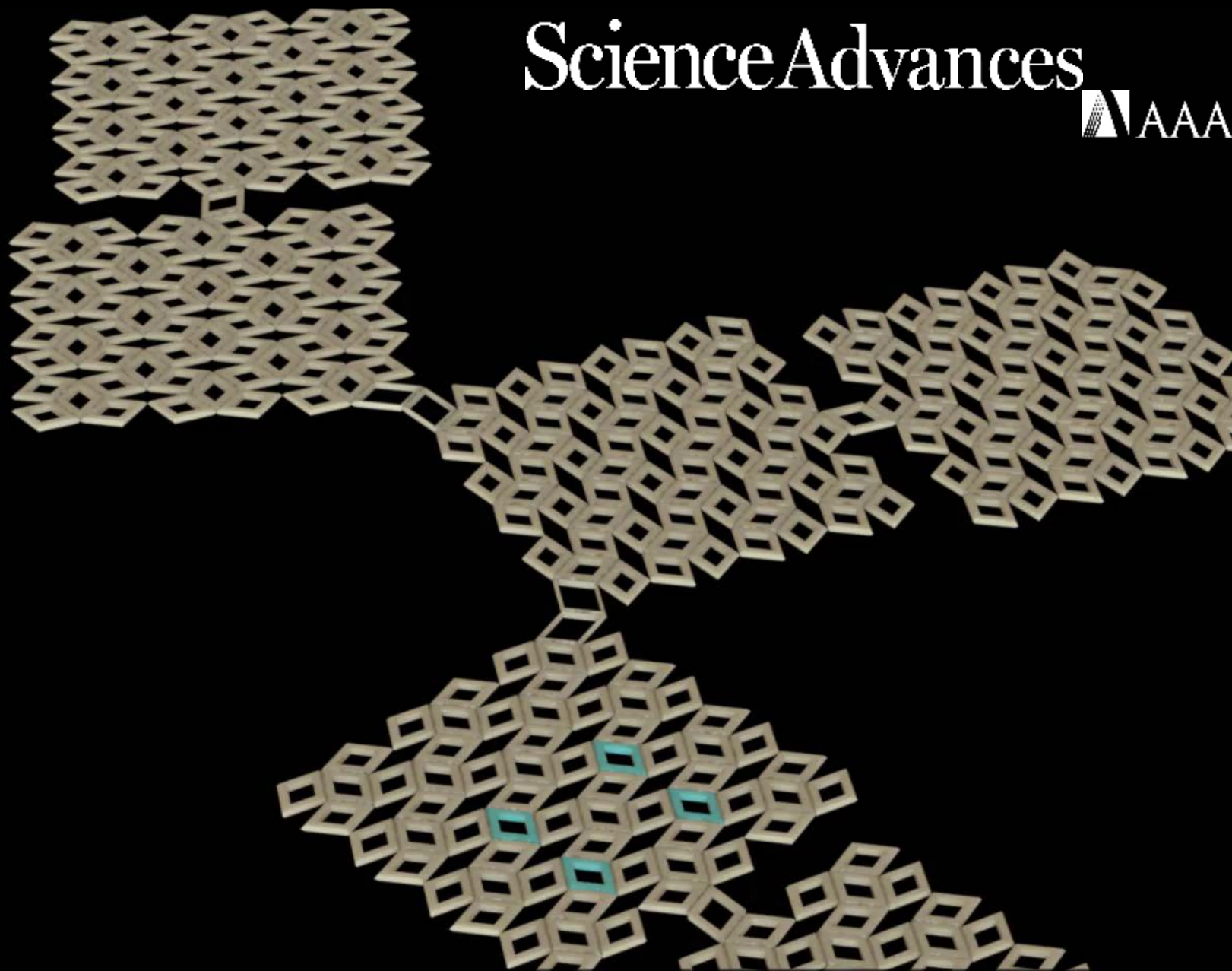
ScienceAdvances

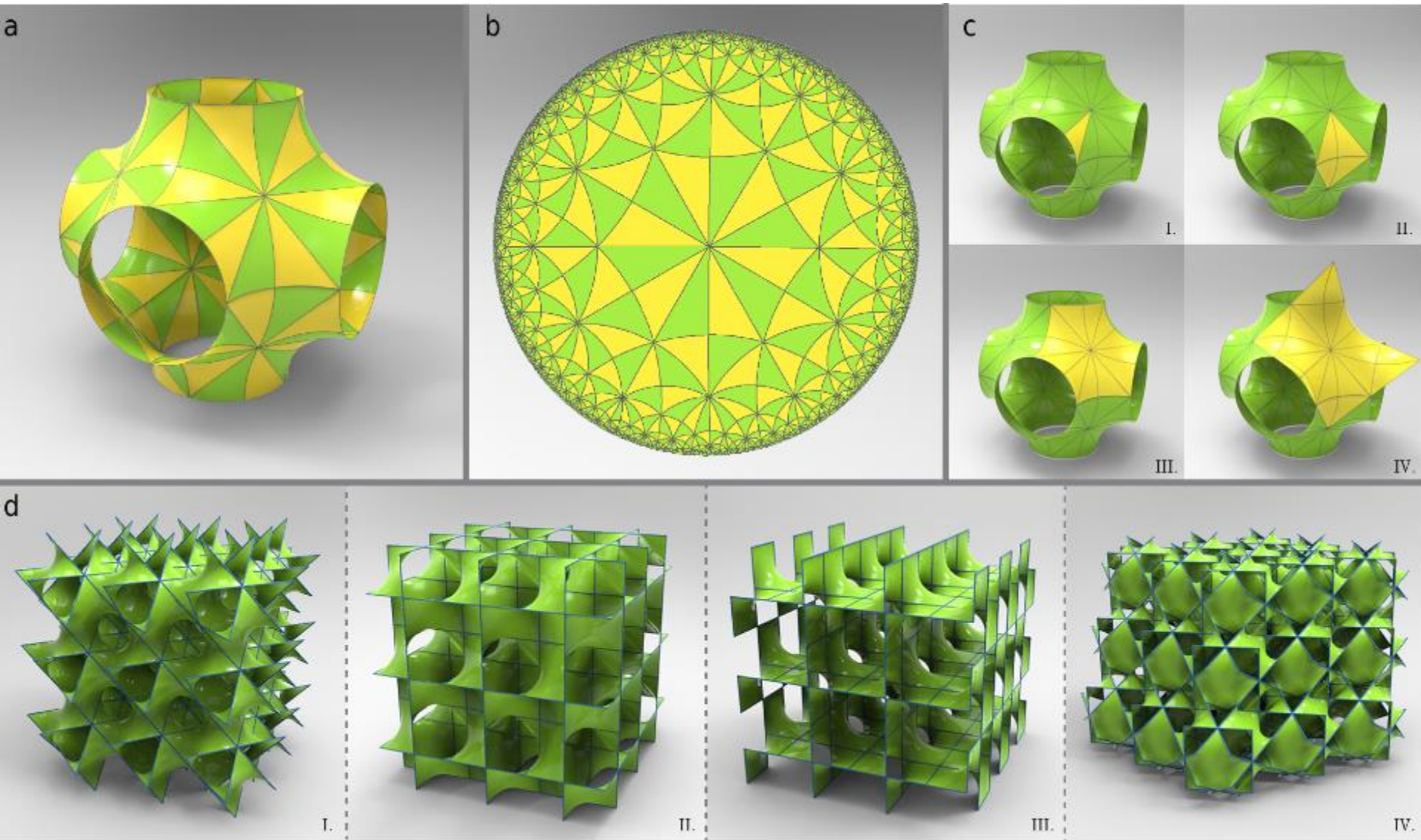


ScienceAdvances

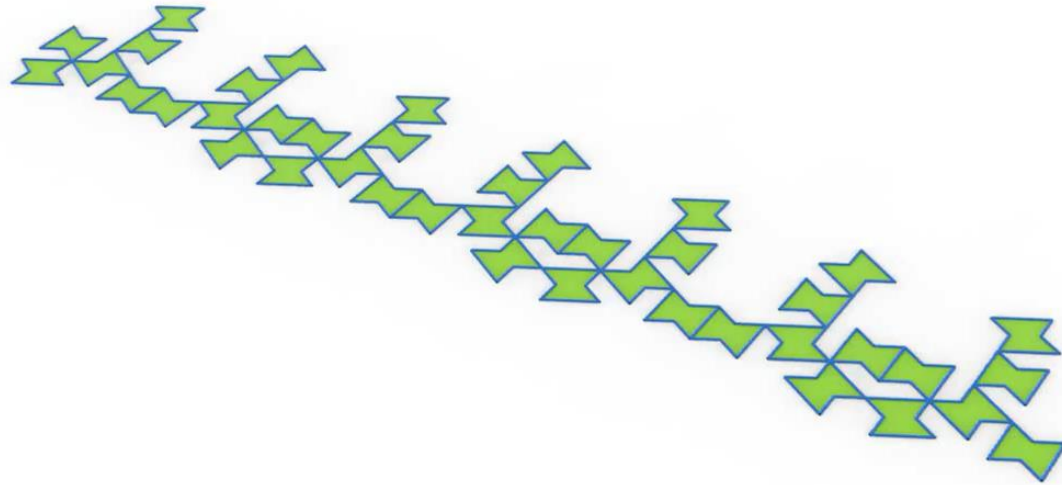


ScienceAdvances

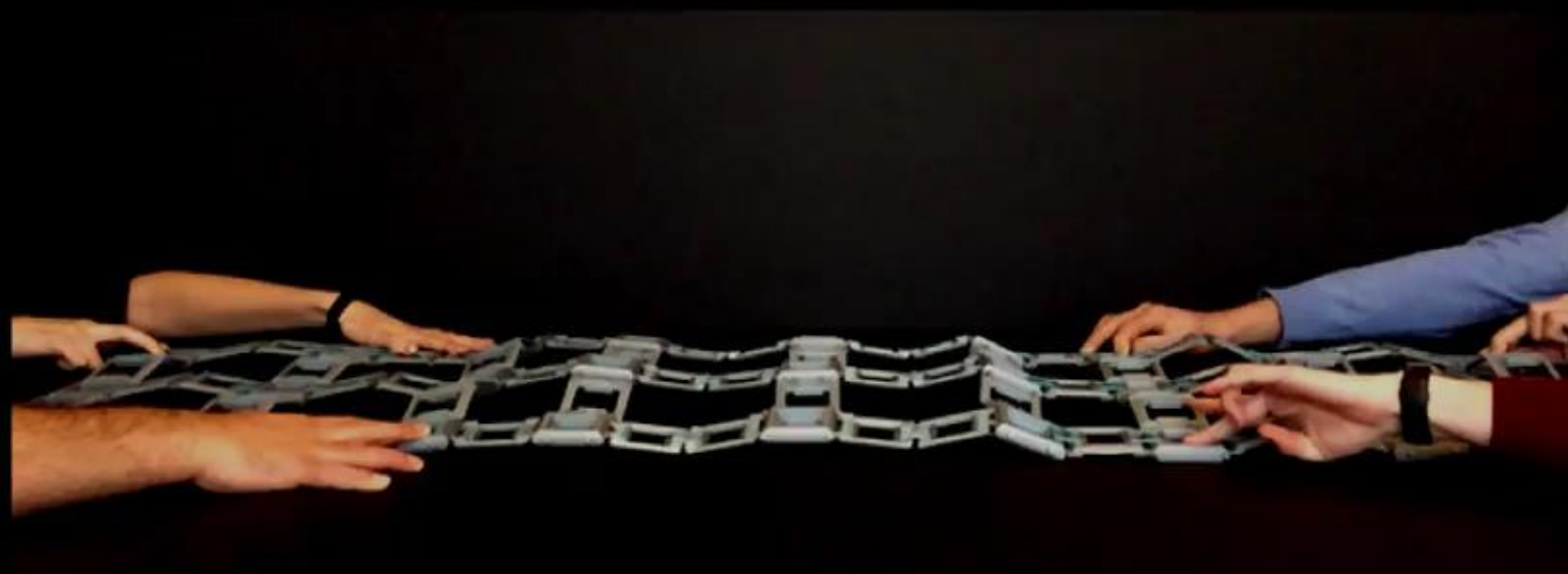




Applied Materials Today, 2019



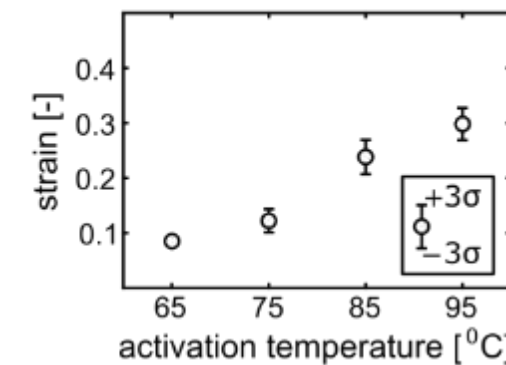
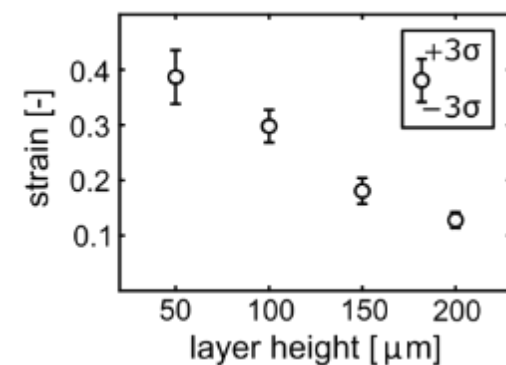
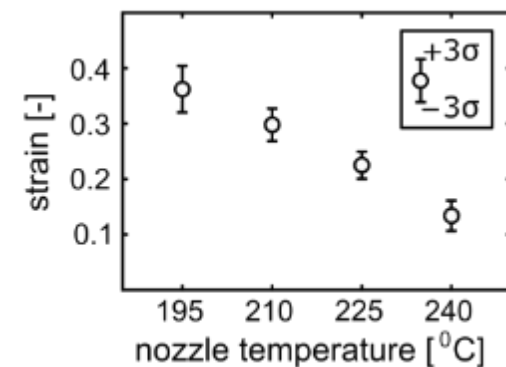
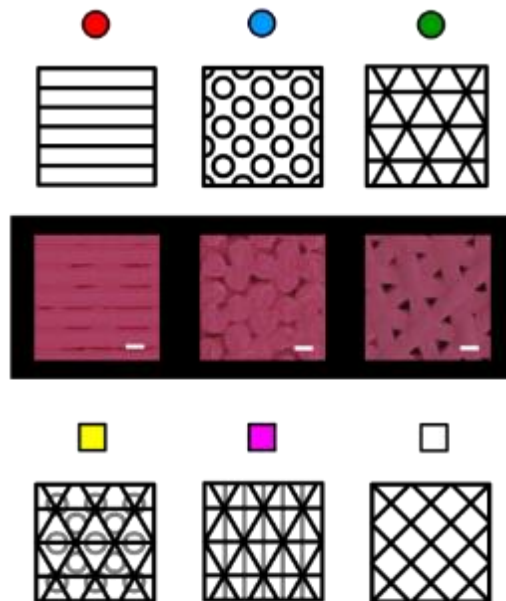
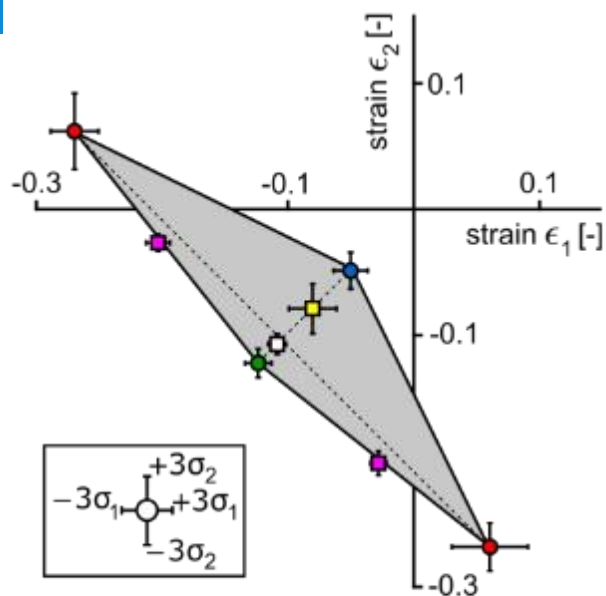
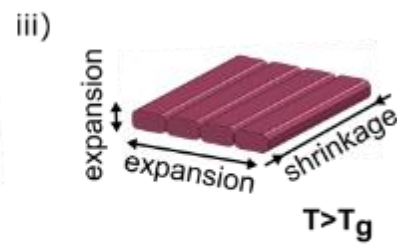
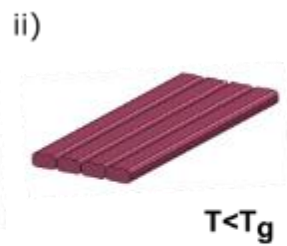
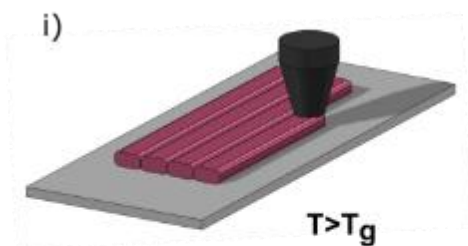
Applied Materials Today, 2019

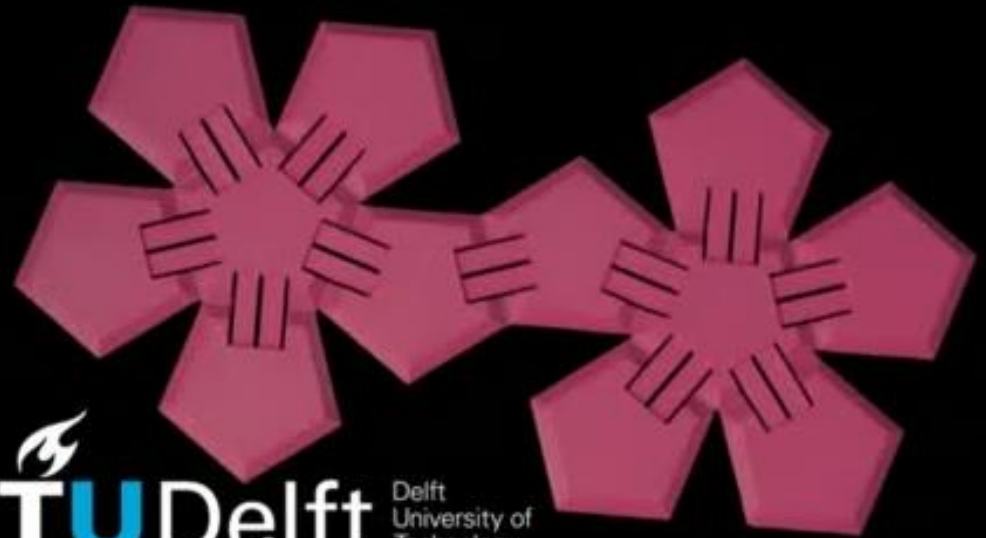


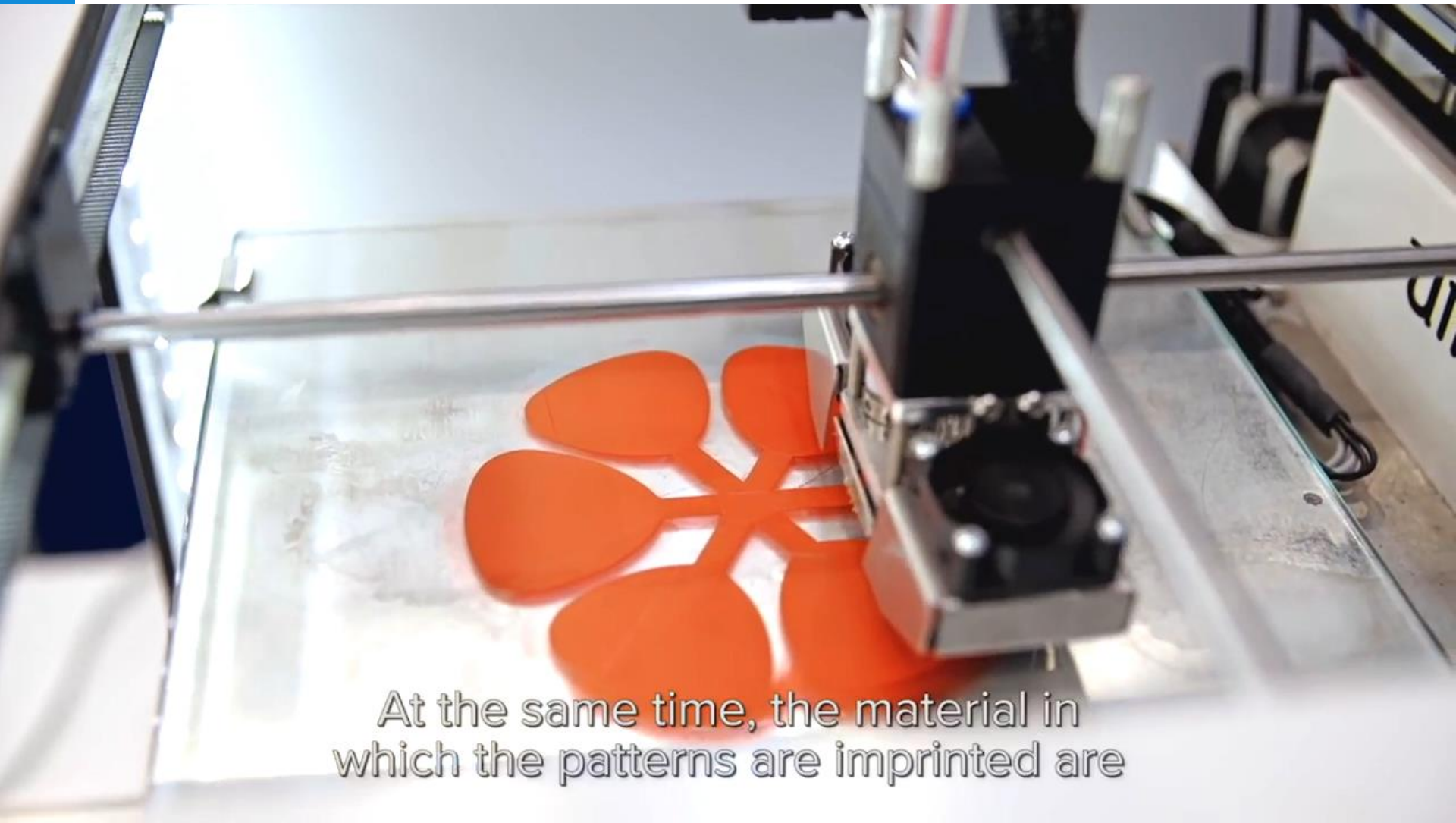
0.25x speed

ScienceAdvances





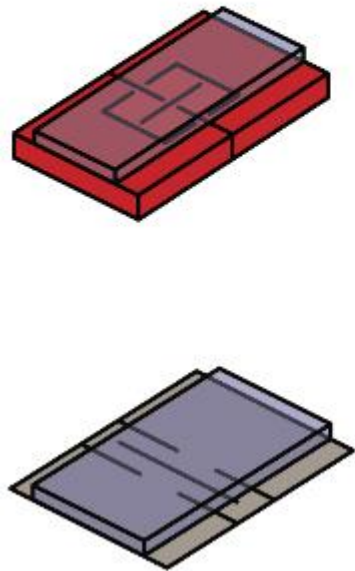




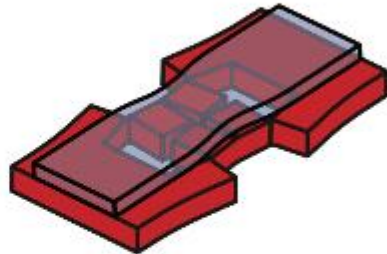
At the same time, the material in which the patterns are imprinted are

Mechanical shape-shifting

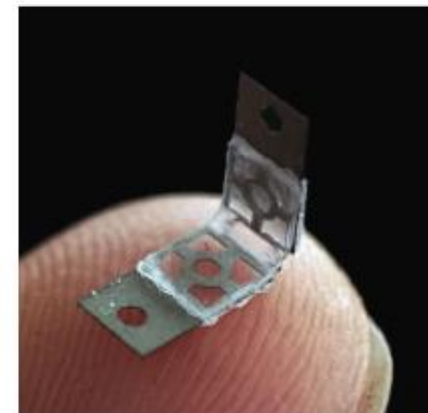
initial

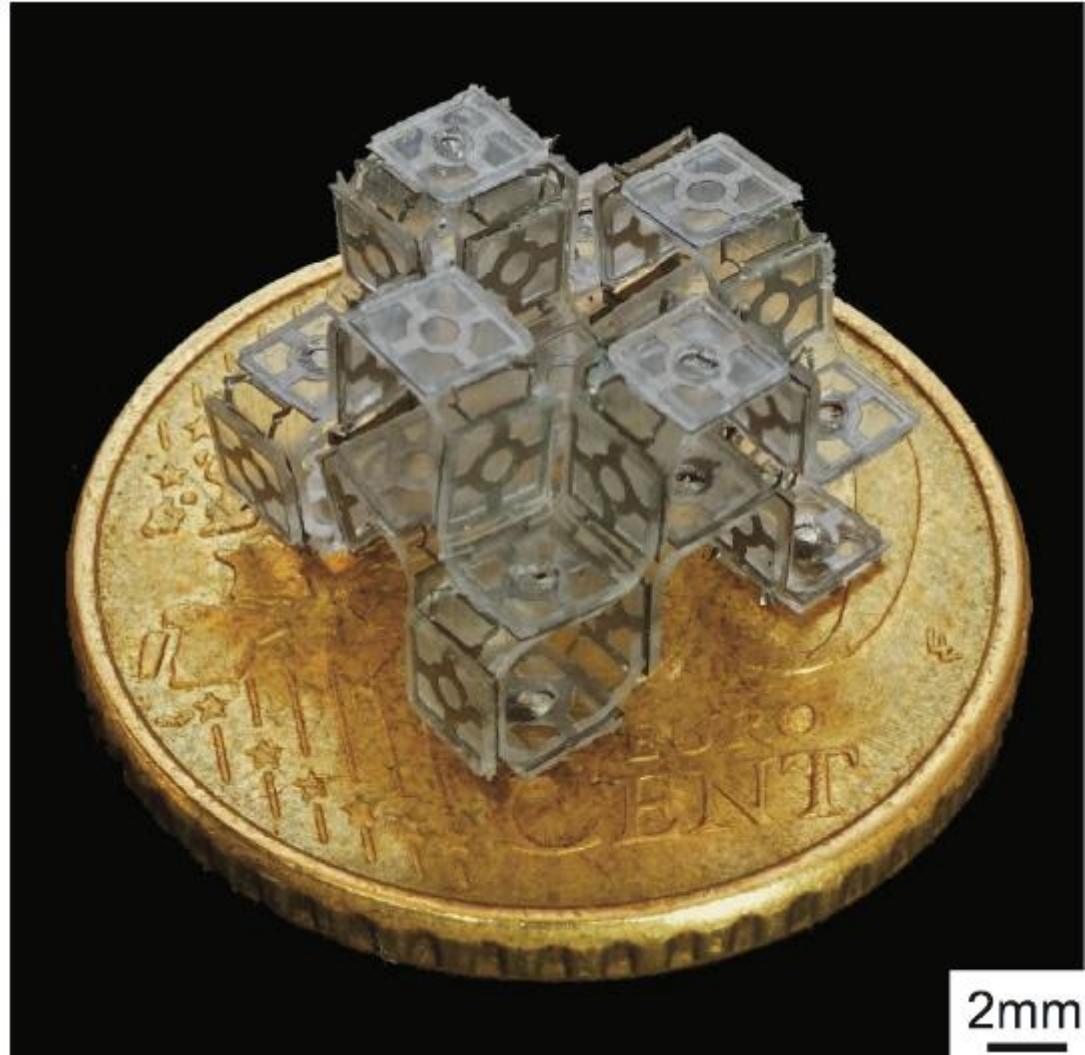
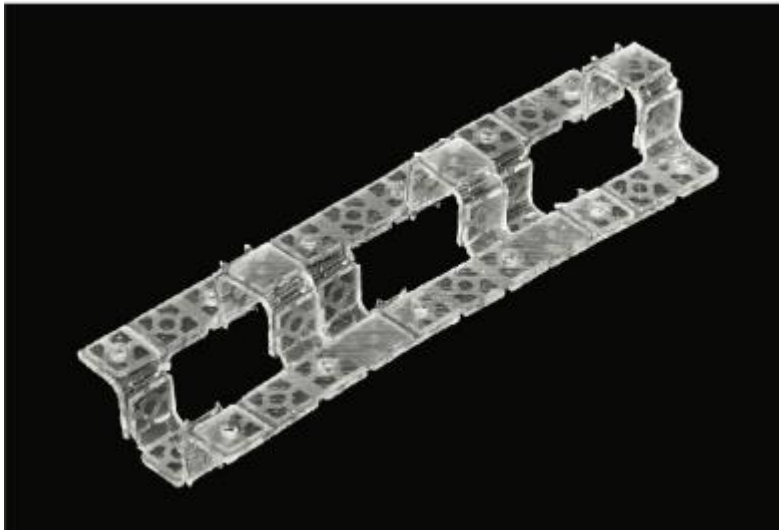
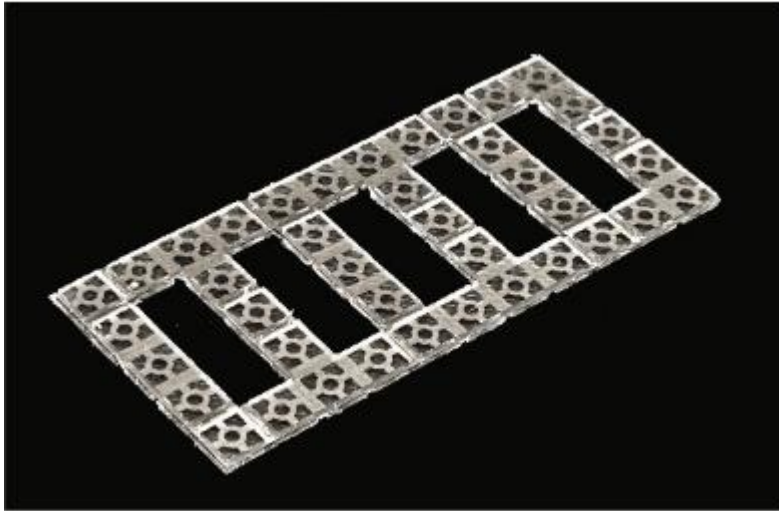


stretched

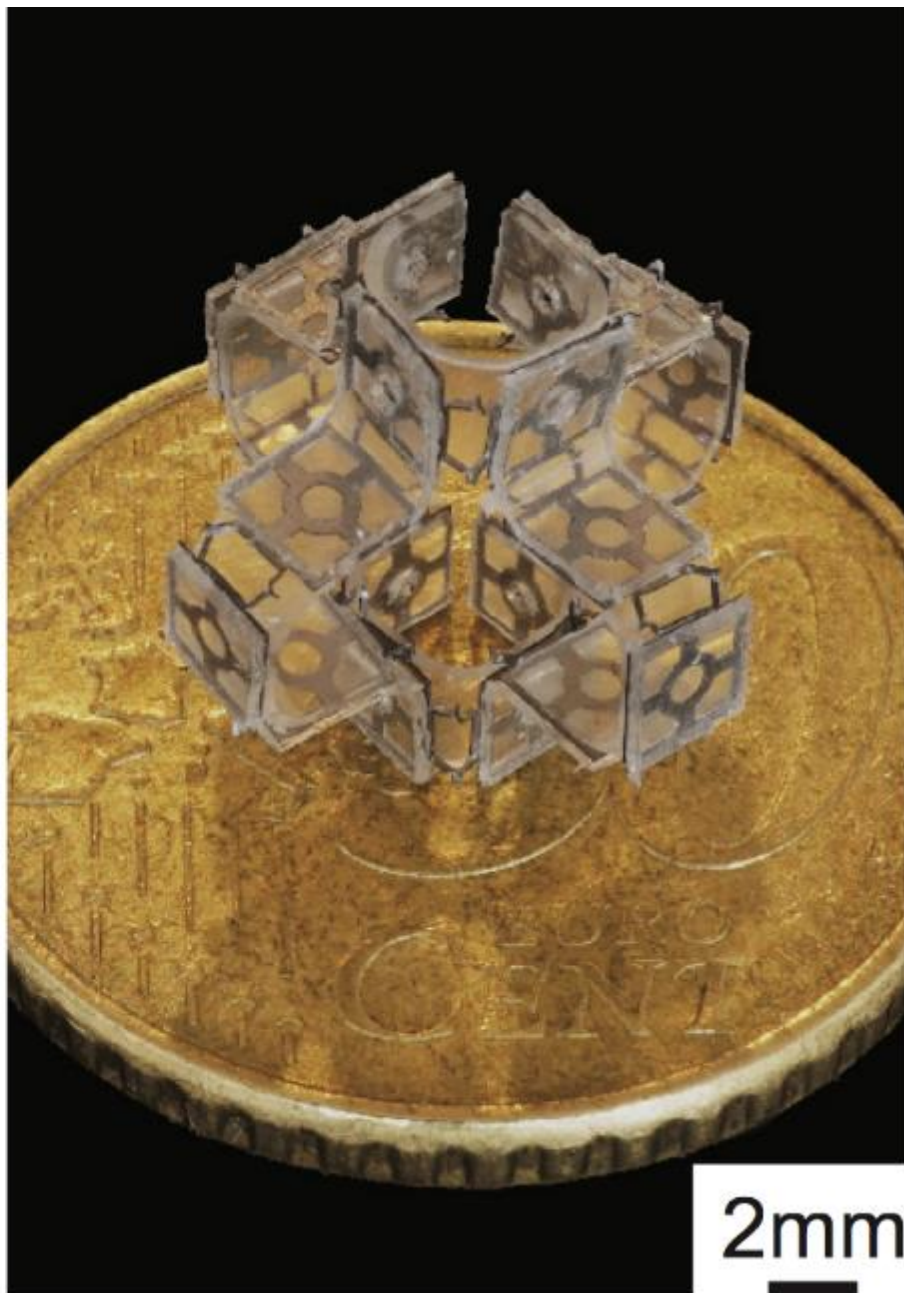
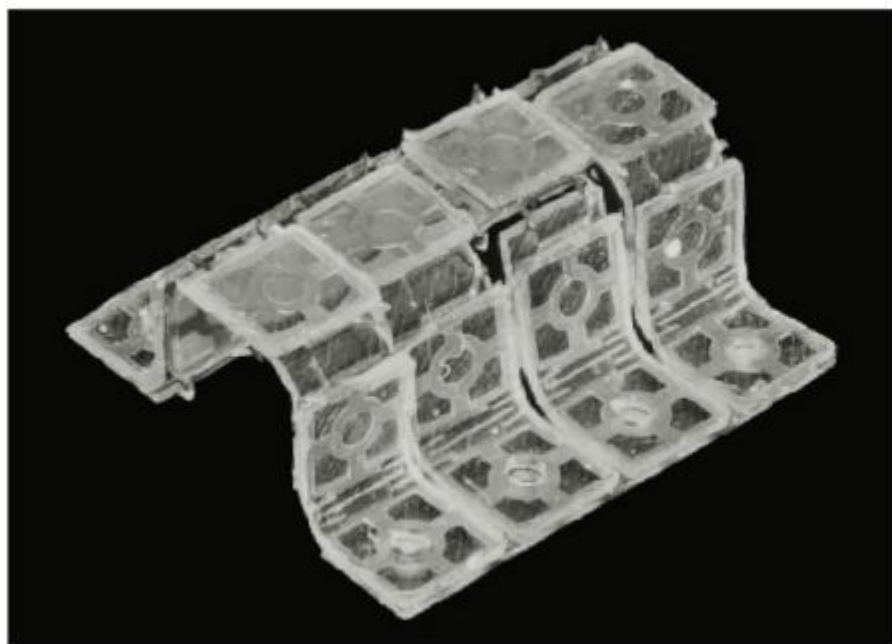
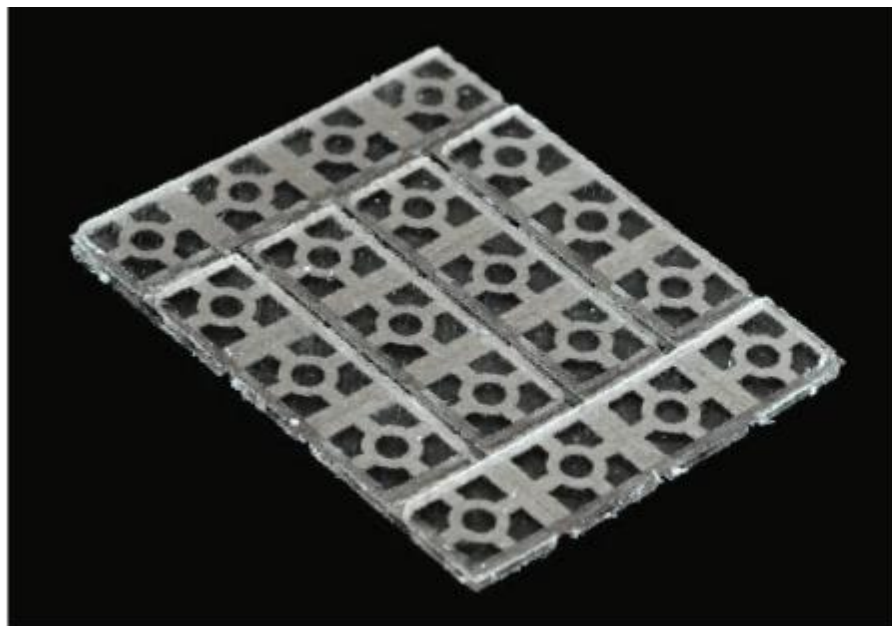


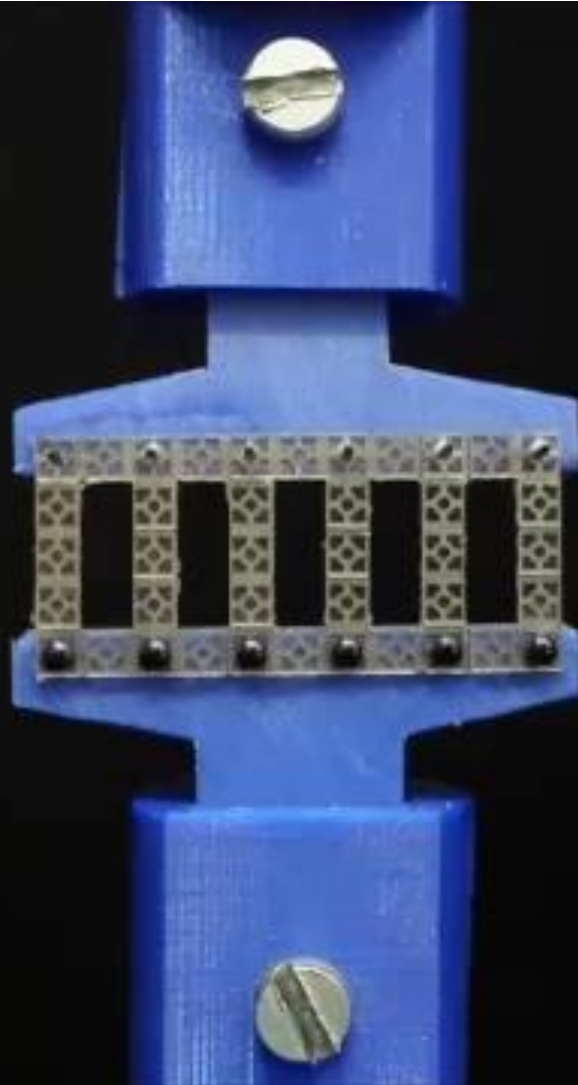
released



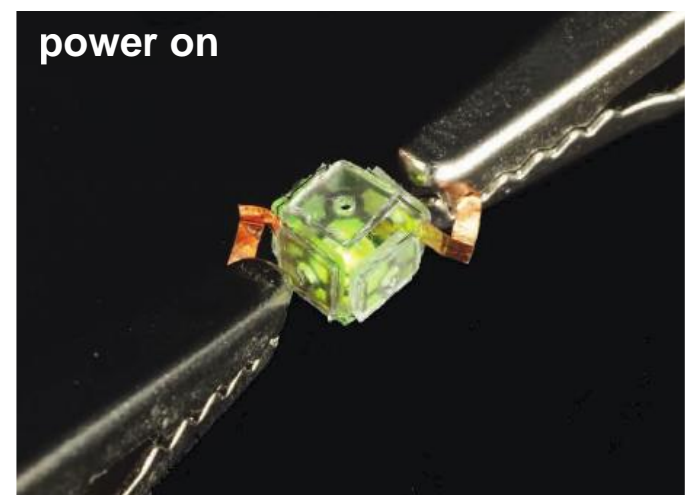
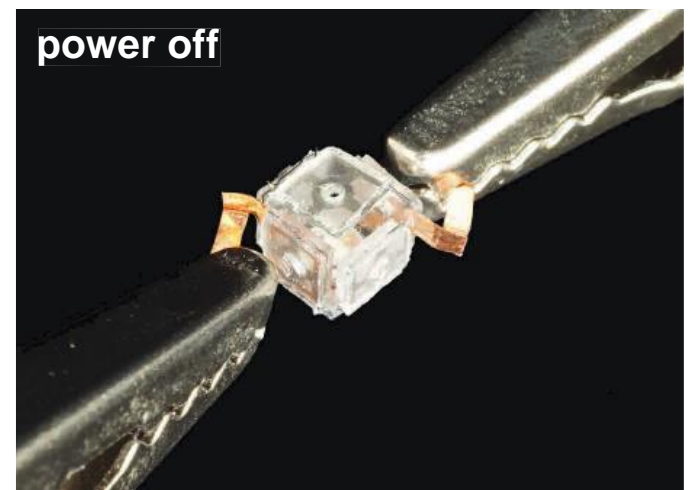
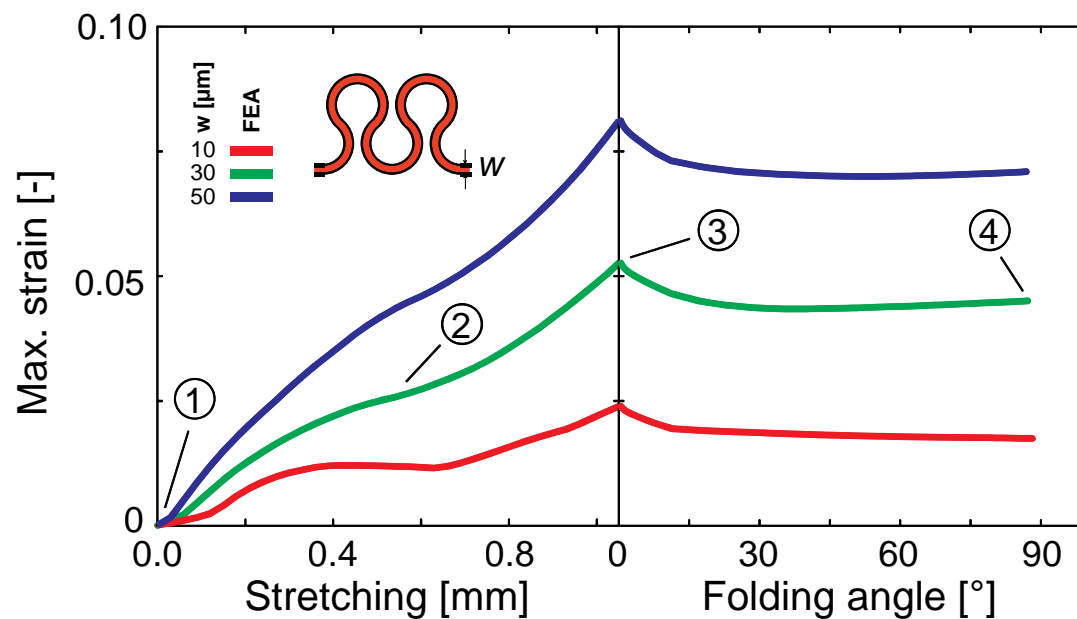
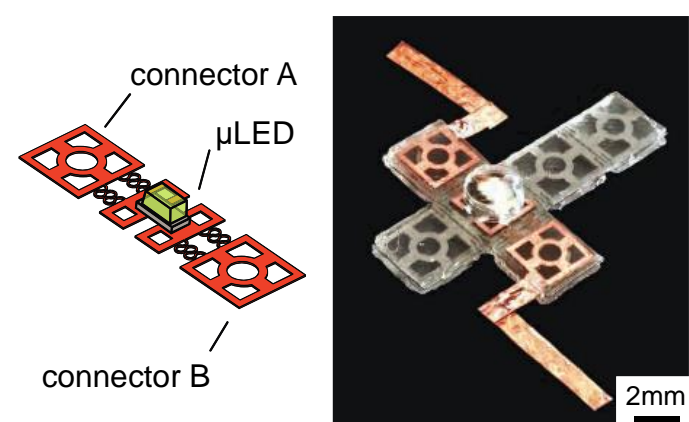
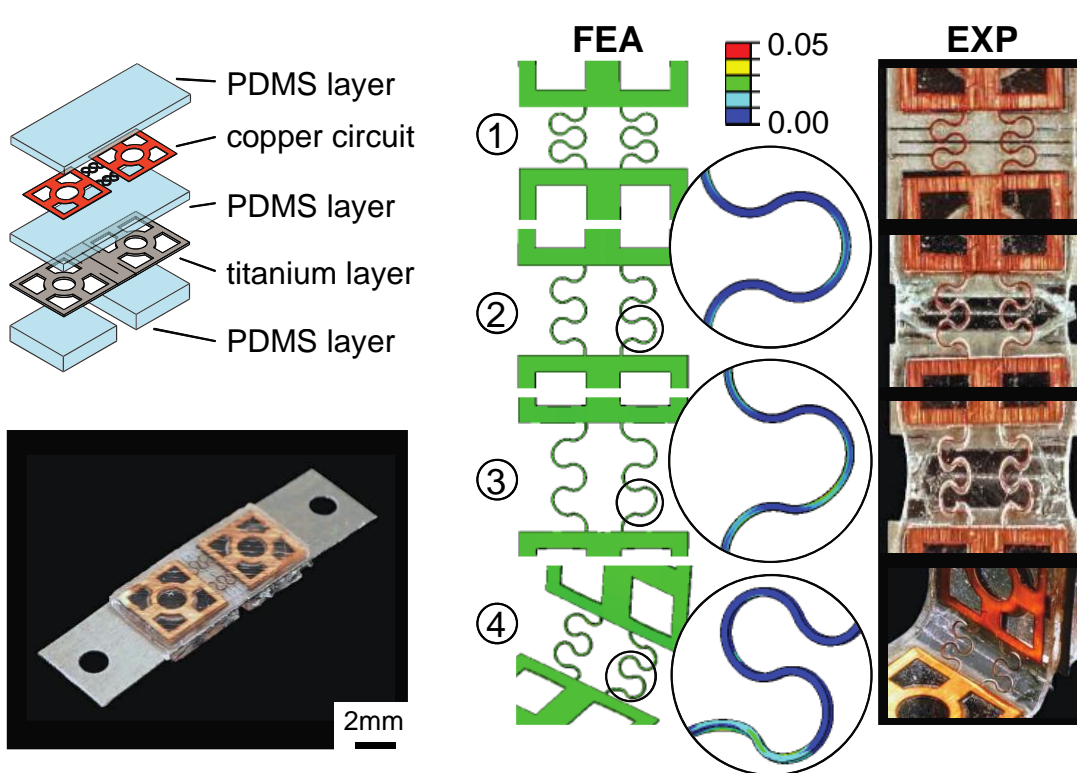


Materials Today, 2019





Stretch A



Supported By The European Regional Development Fund
This project has received funding from the Interreg 2 Seas
programme 2014-2020 co-funded by the European Regional
Development Fund under subsidy contract No 2S04-014_3DMed.

3DMed

Development and streamlined integration of **3D** printing technologies
to enable advanced **med**ical treatment and its widespread application



The Challenge



Patient-specific
solutions



Complexity and
miniaturization



Streamlined care

3DMed partners



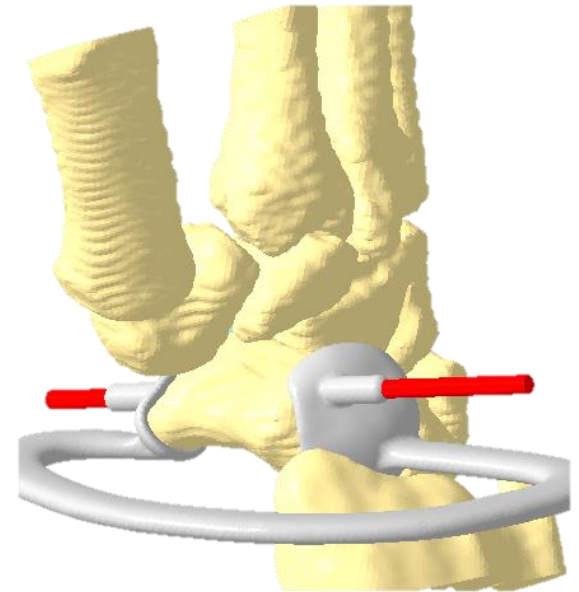
Types of medical devices



Prosthetics/orthotics



Implants



Medical instruments

Some early prototypes



