

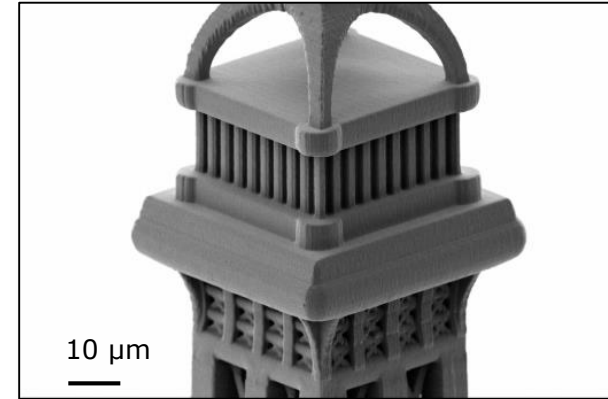
Additive Fertigung von Mikro- und Nanobauteilen

Anwendungen in Medizin und Industrie

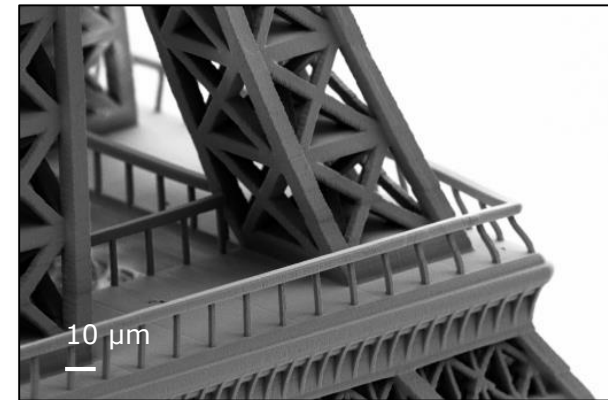
Dr. Jochen Zimmer, Sales Manager



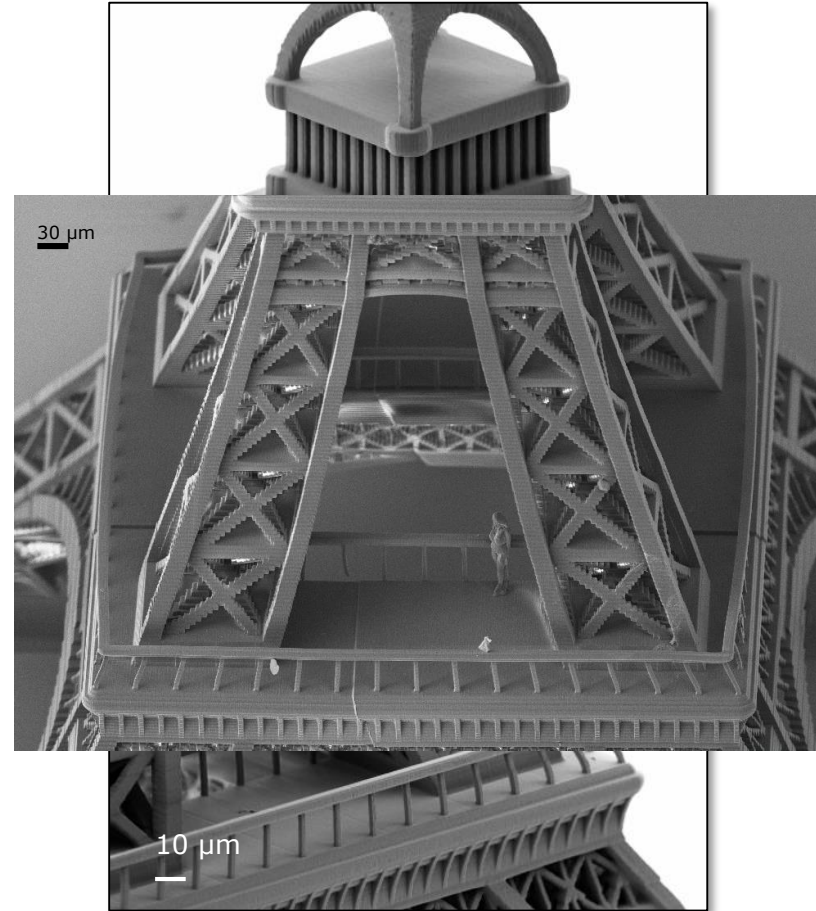
Additive Fertigung auf der μm -Skala



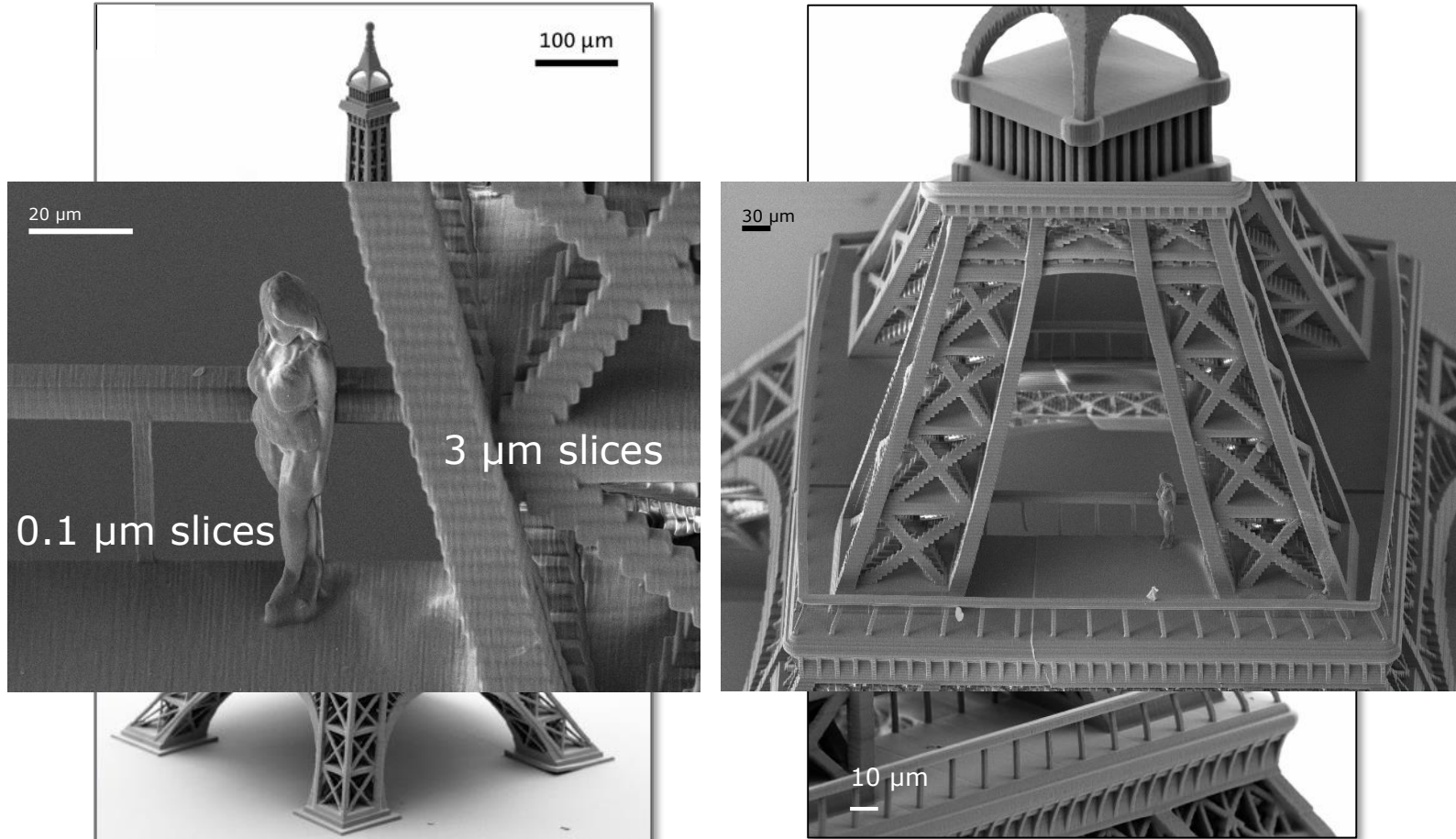
2,000 Schichten – 1 Prozess-Schritt!



Additive Fertigung auf der μm -Skala



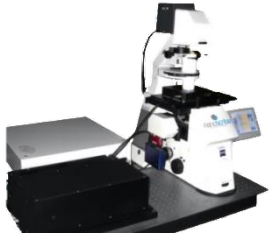
Additive Fertigung auf der μm -Skala



Meilensteine

2006-07

Printer prototypes



2008

Photonic Professional

1st printer shipped



2009

Print Materials

Global Expansion
Growing markets



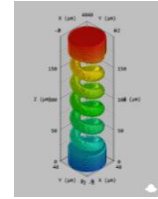
2014

1st industry
lead customer



2016

Print-job editor
with **recipes**



Enabling Science

Enabling Industry



2007

Nanoscribe GmbH
founded



2008

Carl Zeiss Venture
acquires shares



2014

Photonic Professional GT
1,000× speed-up

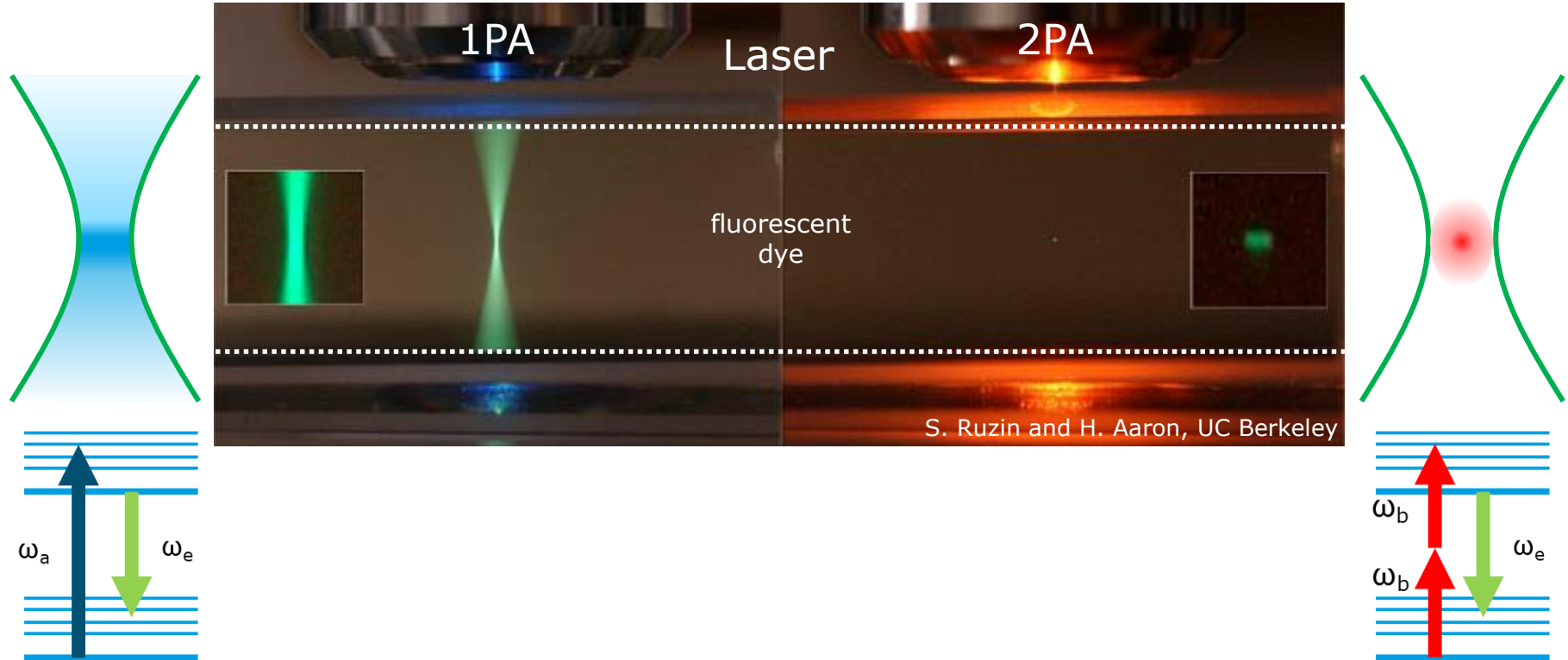


2018

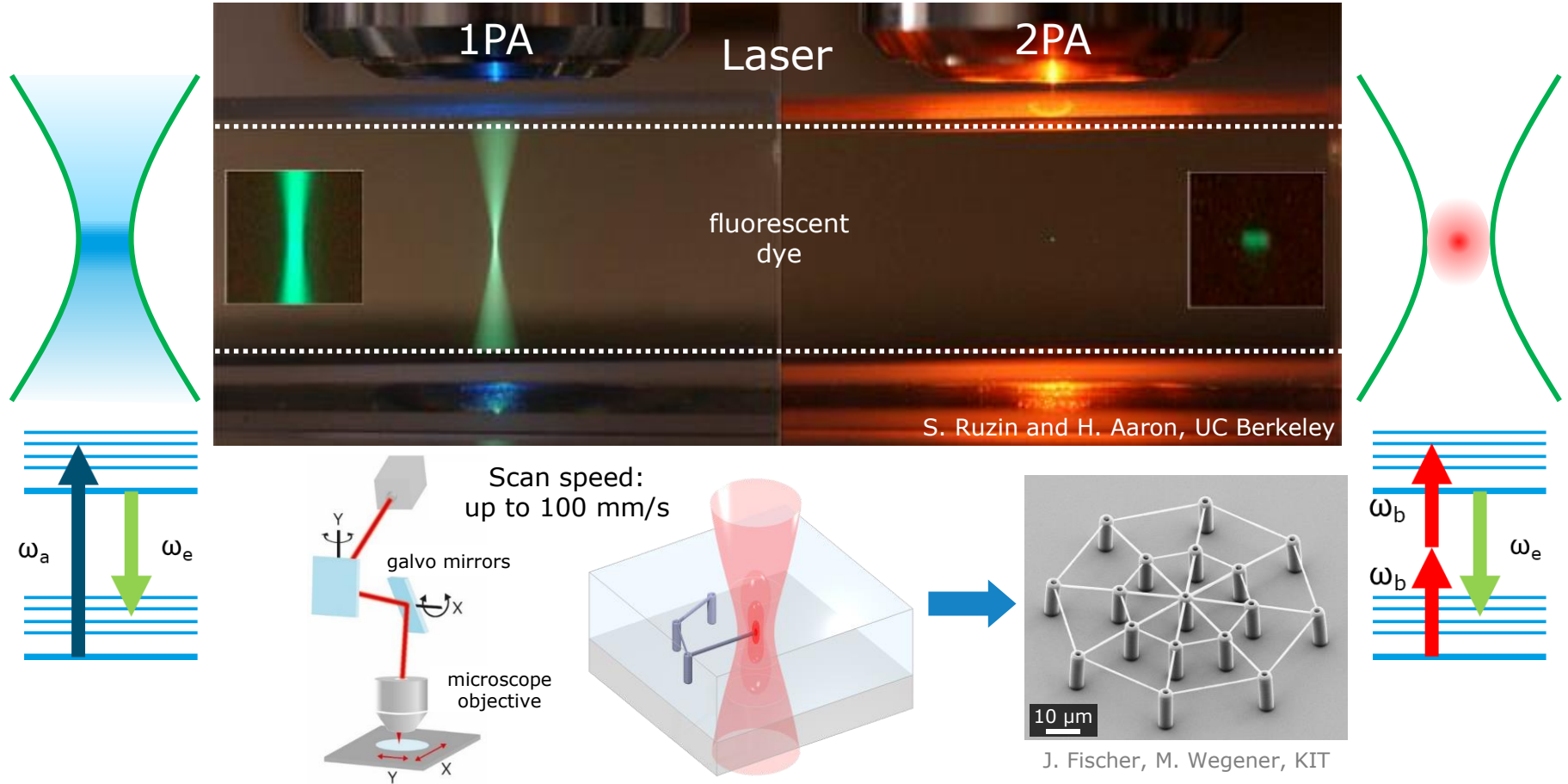
>1000 users
>30 countries
>60 employees

Technologie des 3D Mikrodruks

Zwei-Photonen-Absorption



Zwei-Photonen-Absorption

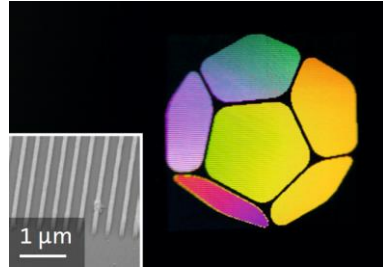


Sub-Mikrometer-Strukturen und mm-Objekte

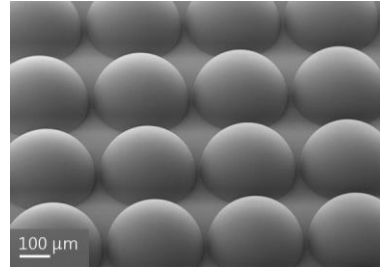
> 1 mm

meso

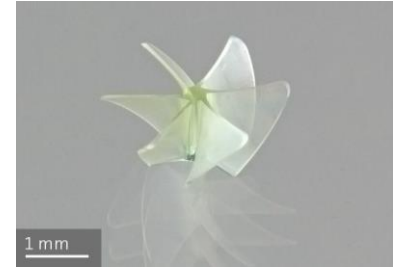
2D



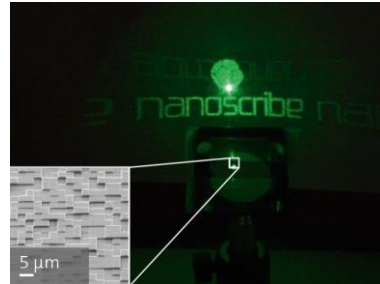
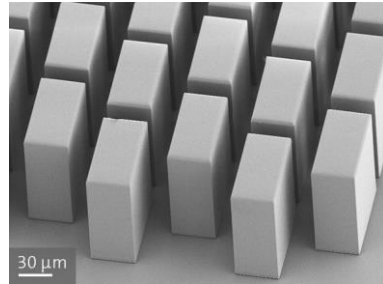
2.5D



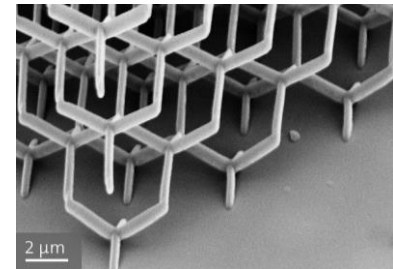
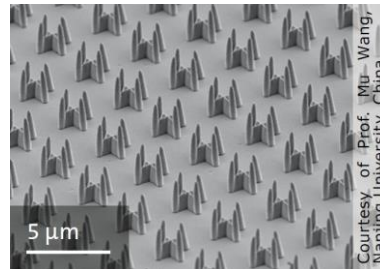
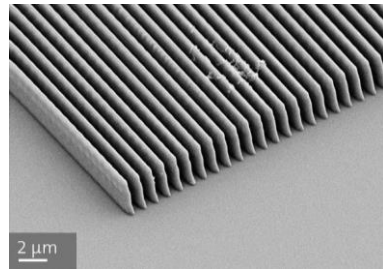
3D



micro

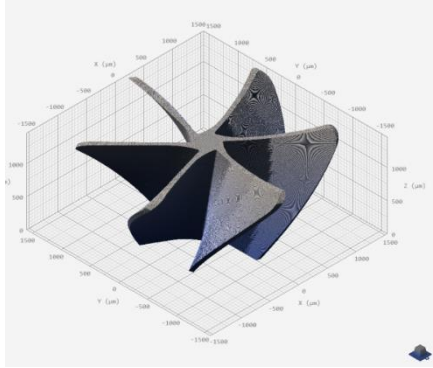


nano



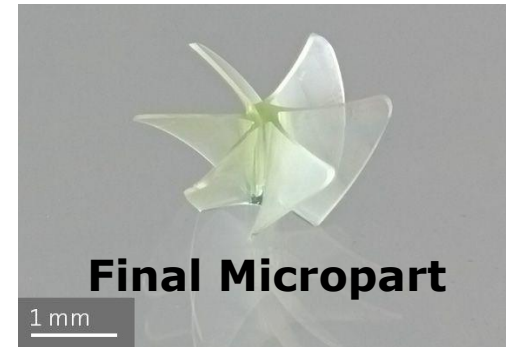
< 1 μm

3D Mikrodruck Workflow

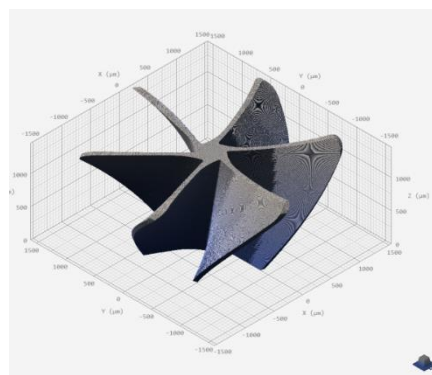


3D CAD model

?

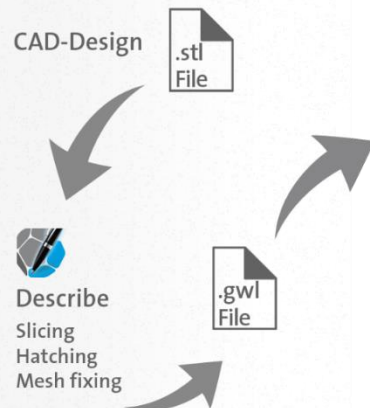


3D Mikrodruck Workflow



3D CAD model

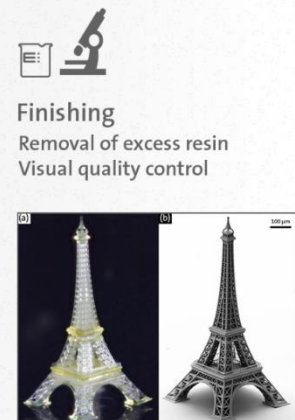
1. Preparation



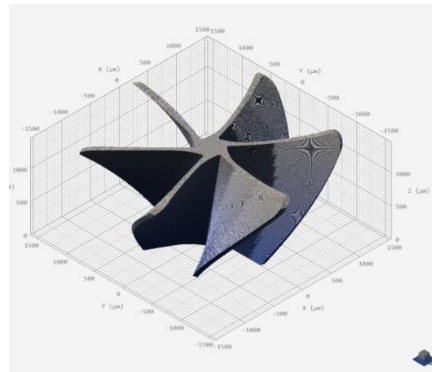
2. Production



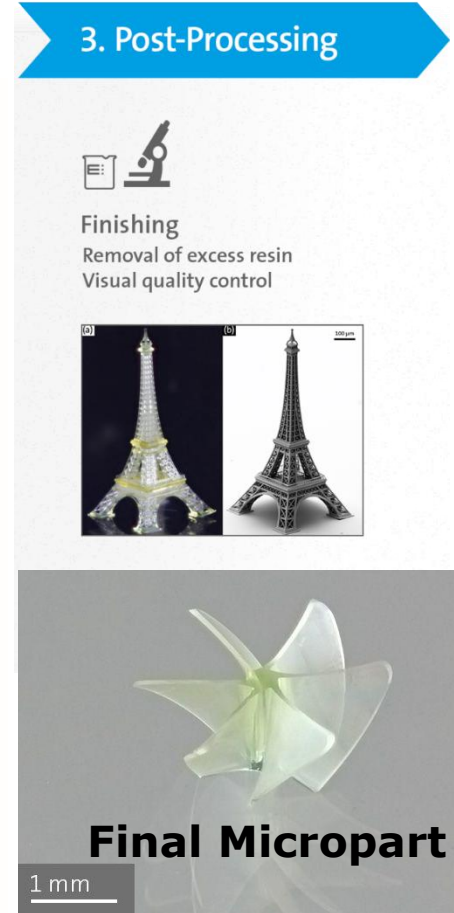
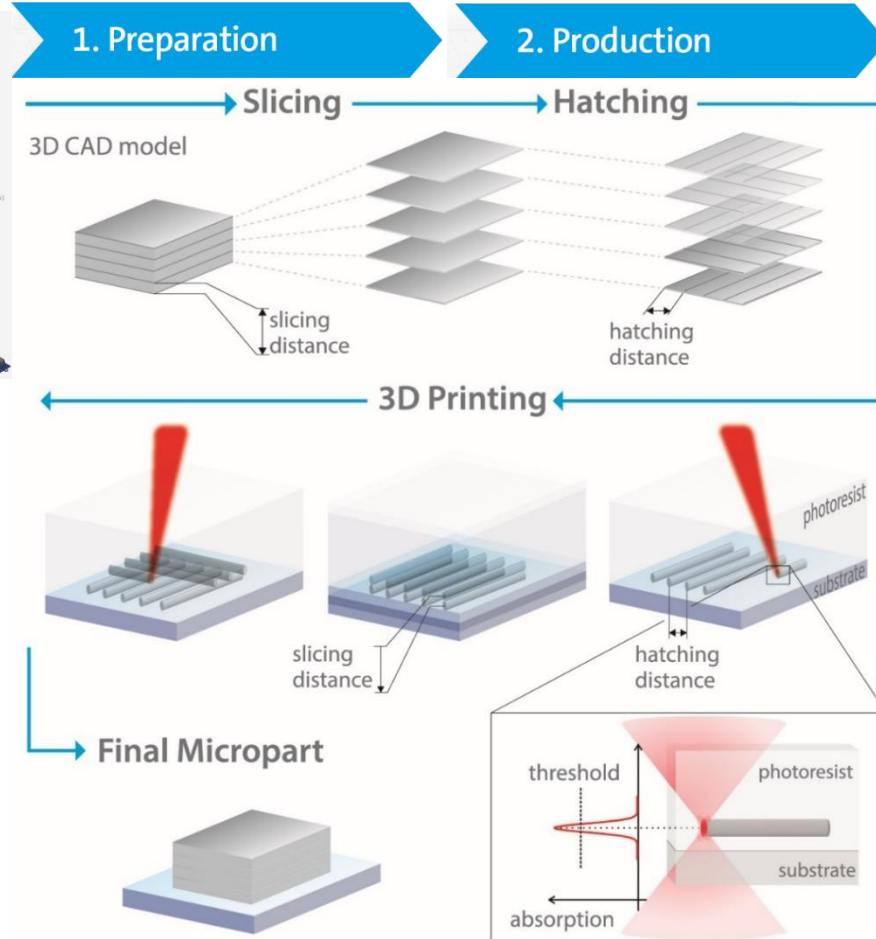
3. Post-Processing



3D Mikrodruck Workflow

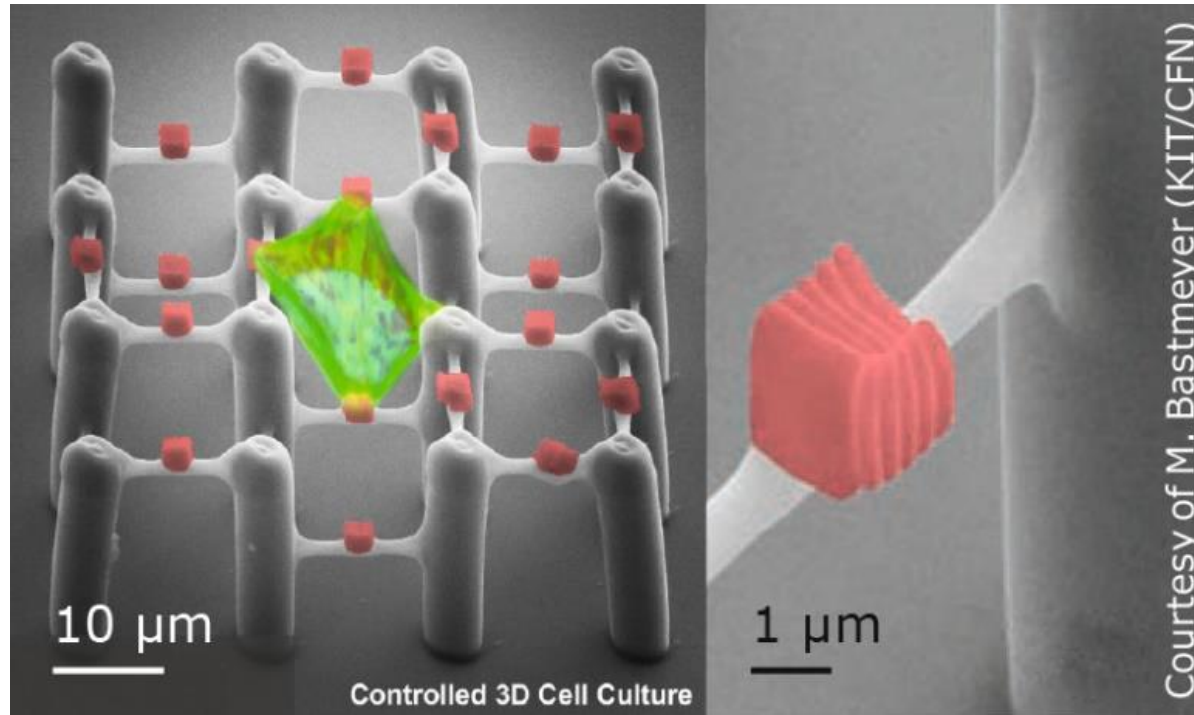


3D CAD model



Medizinische Anwendung: auf der Skala einzelner Zellen

3D-Gerüste für Zellen



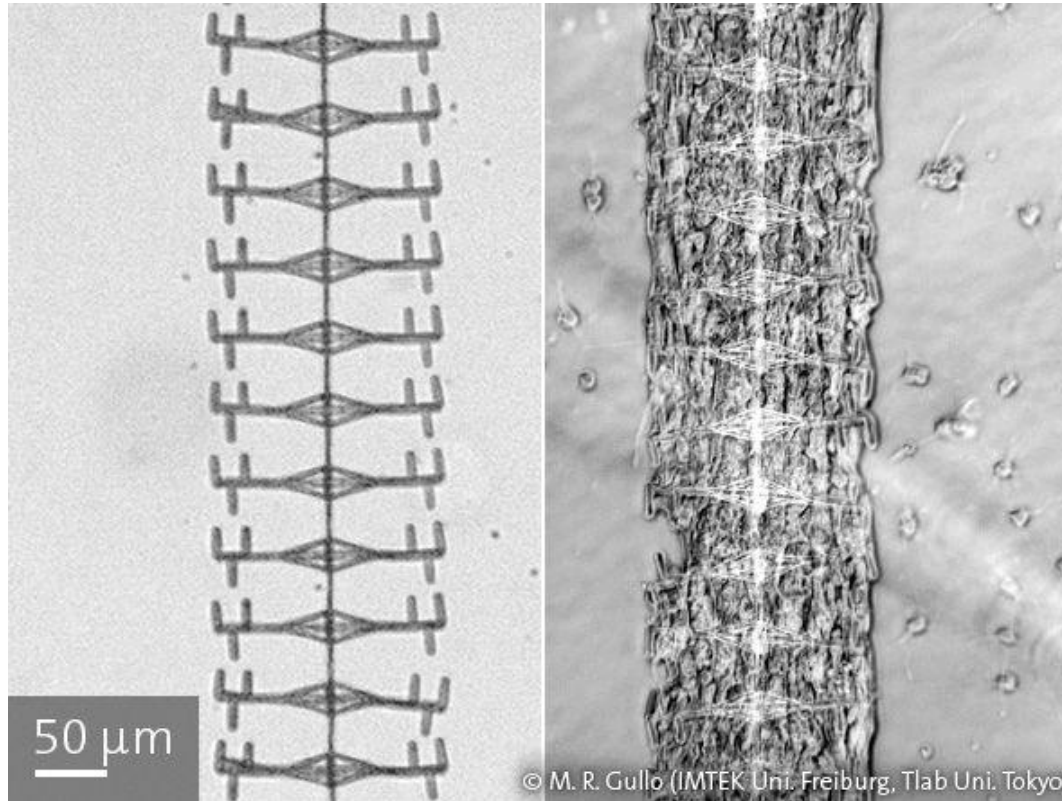
Materials:

ORMOCERE=Protein binding

PEG-DA/PETA=Protein repellant

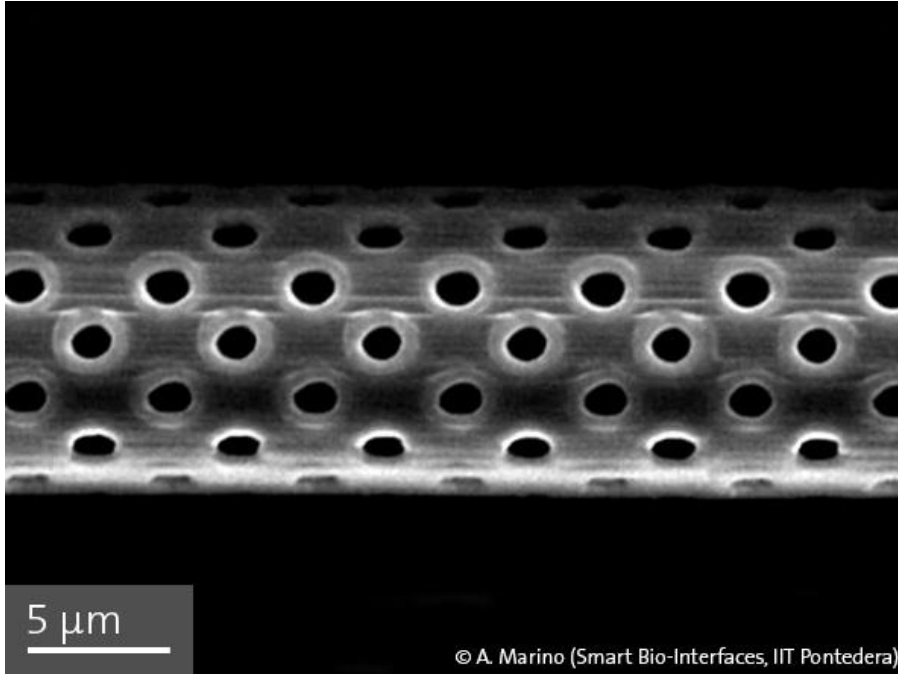
F. Klein & B. Richter et al., Adv. Mater. **23**, 1341-1345 (2011)

Muskelfaser auf dem Chip

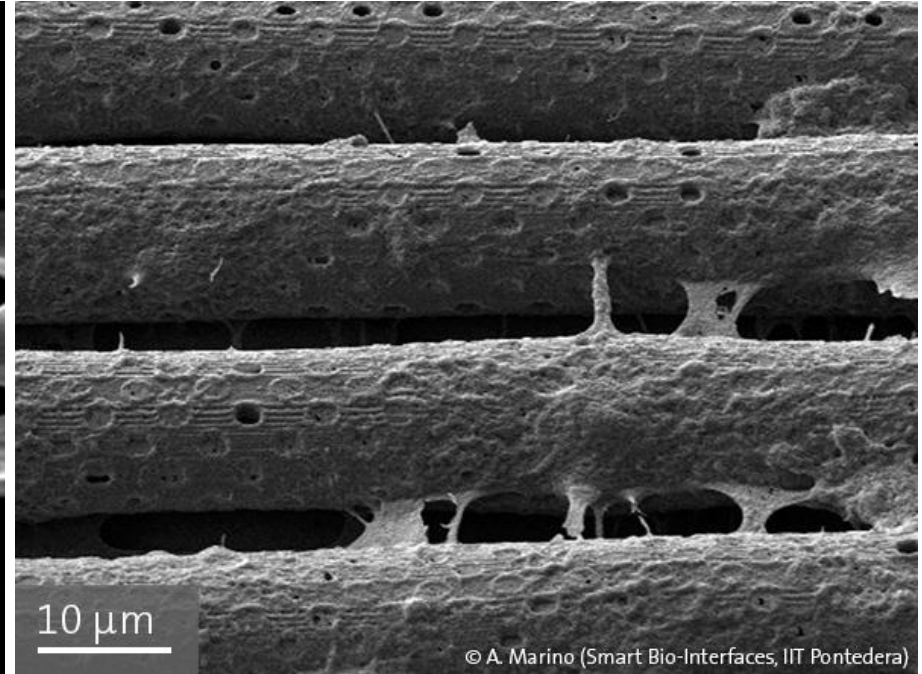


M. Gullo et al., 2017 *IEEE 30th Int. Conf. on MEMS*, pp. 101-104 (2017)

Blut-Hirn-Schranken-Modell auf dem Chip



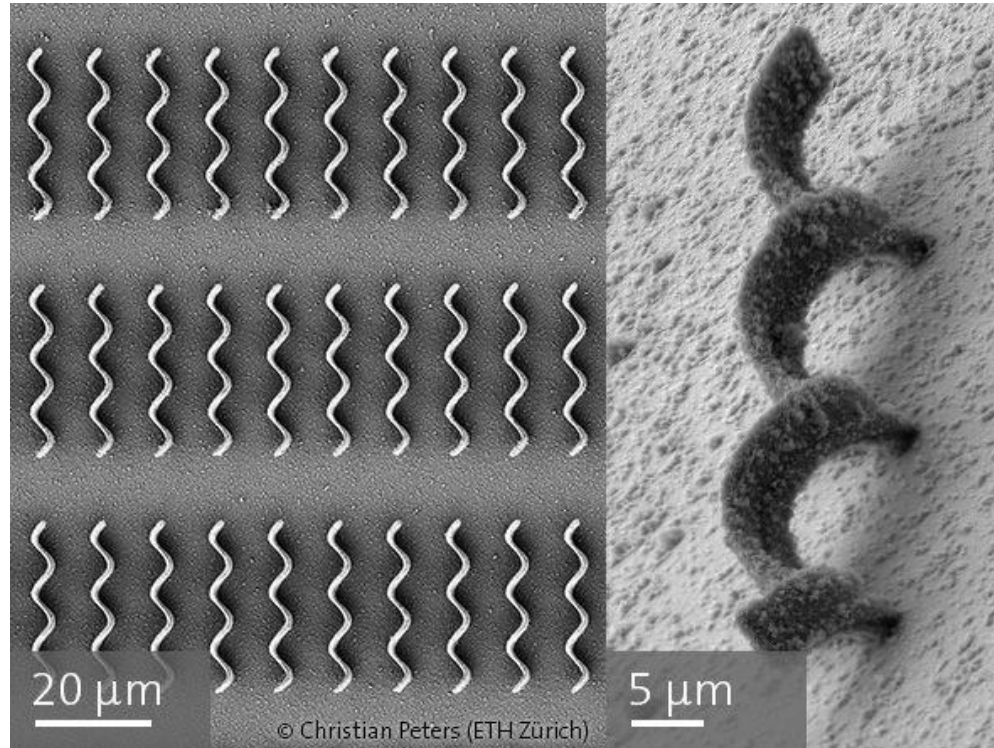
3D printed porous microtube (IP-Dip)



Biohybrid model: colonized tubes (*endothelial-like bEnd.3 and U87 glioblastoma cells*)

A. Marino et al., Small **14**, 1702959 (2018)

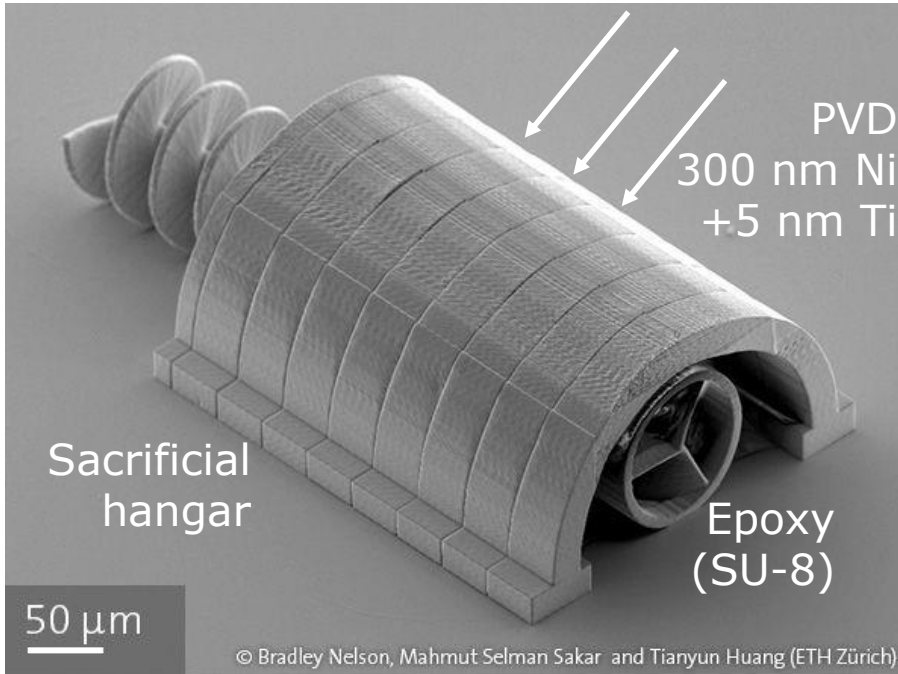
Mikroroboter aus paramagnetischem Hydrogel



Superparamagnetic FF (Fe_3O_4)(2%)

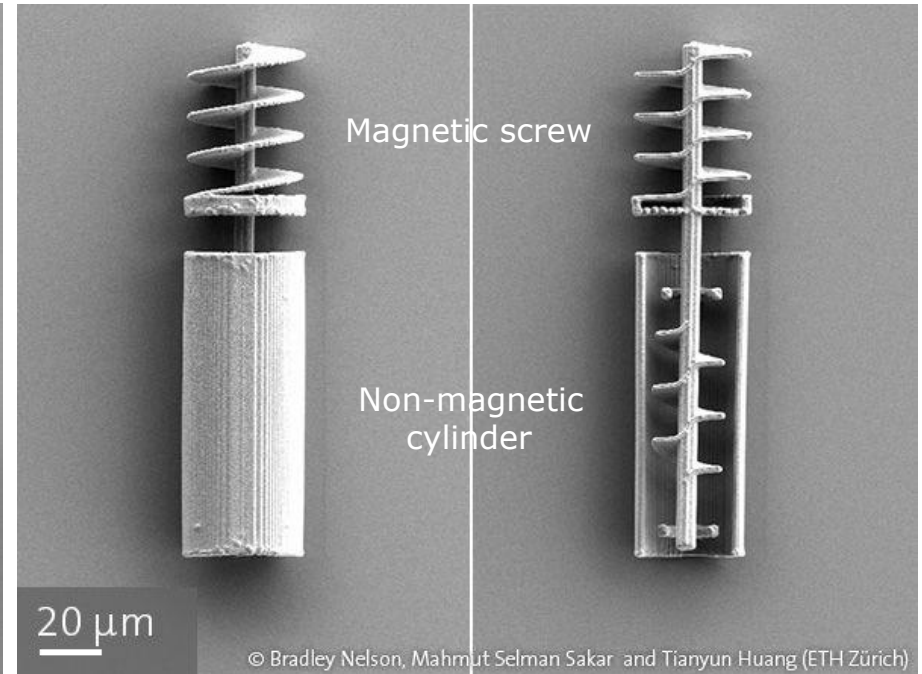
in PEG-DA/TMPE-TA copolymer

C. Peters et al., Adv. Mater. **28**, 533-538 (2016)



Epoxy (SU-8) micromachines

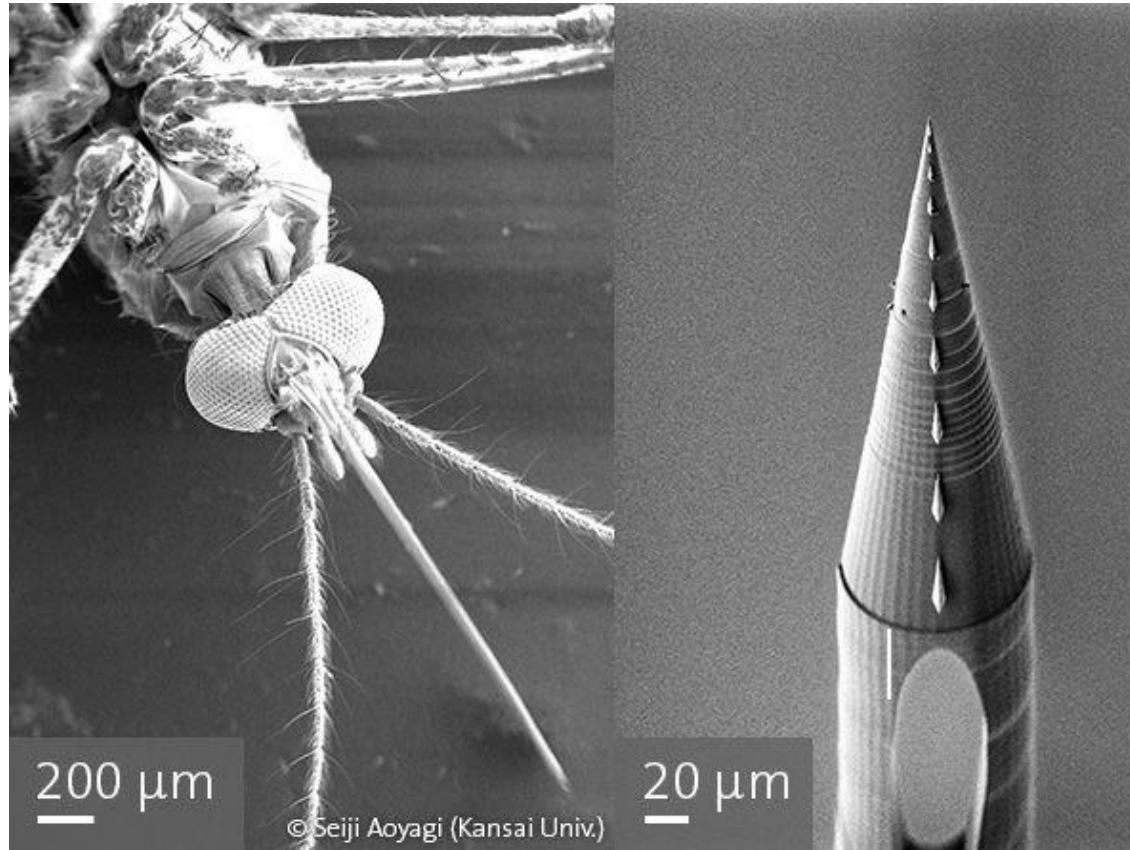
PVD-coated with 300nm Ni / 5 nm Ti



T.-Y. Huang et al., Adv. Mater. **27**, 6644–6650 (2015)

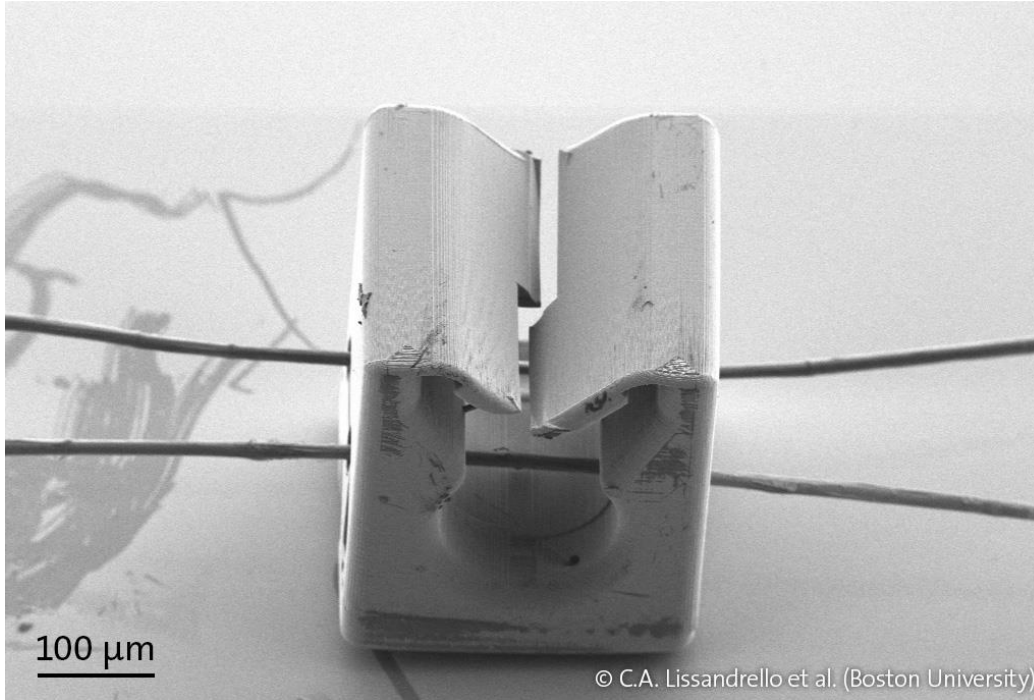
Medizinische Anwendung: Minimalinvasive Werkzeuge

Mikronadeln für schmerzfreie Spritzen

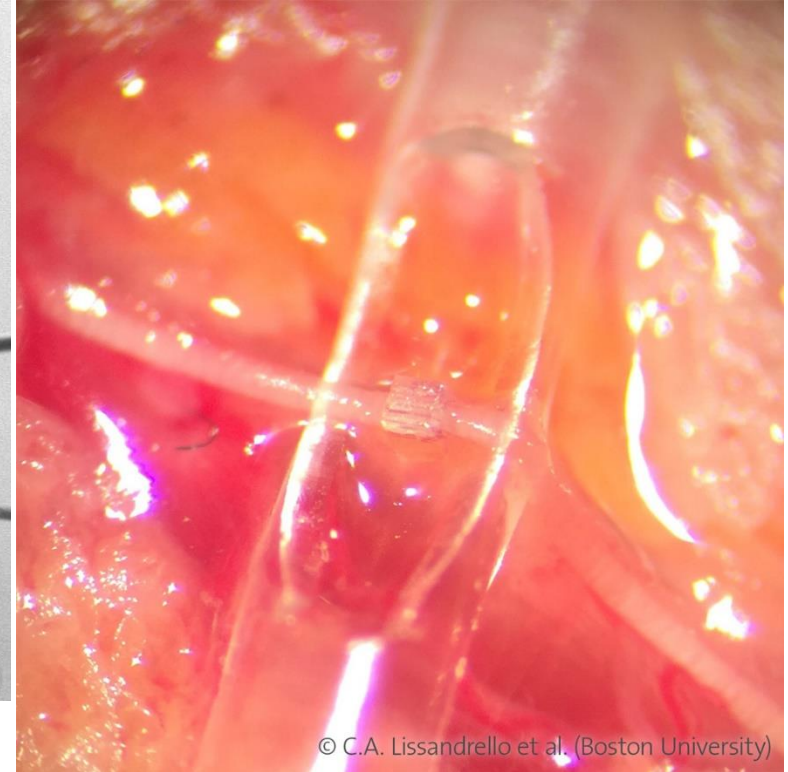


M. Suzuki et al., 18th Int. Conf. on Solid-State Sensors, Actuators and Microsystems (TRANSDUCERS), 121-124 (2015)

Minimalinvasive Nervenklammer

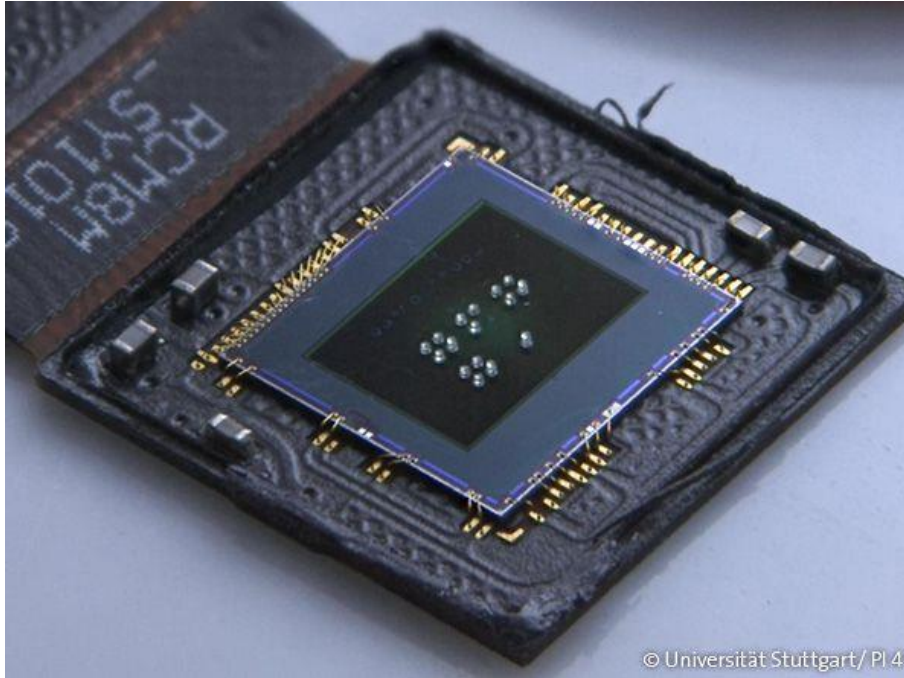


Material: IP-Dip, carbon nanotube fibers



C.A. Lissandrello et al., J. Neural Eng. **14**, 036006 (2017)

Optik, maximal integriert (z.B. digitale Endoskopie)



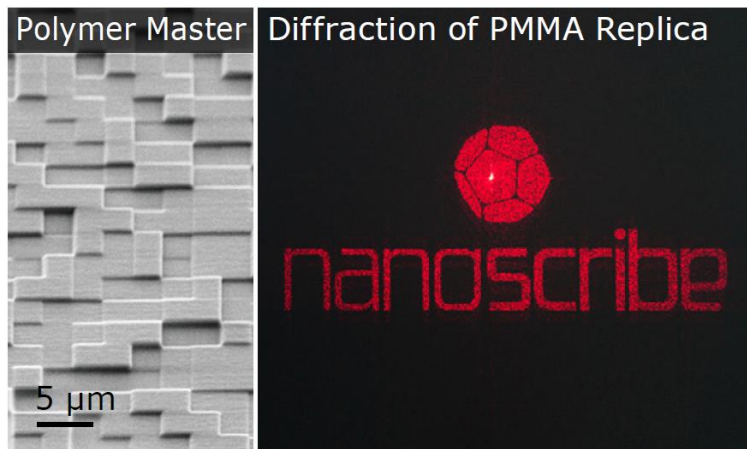
Material: IP-S (Acrylate)

S. Thiele et al., Science Advances **3** (2), e1602655 (2017)

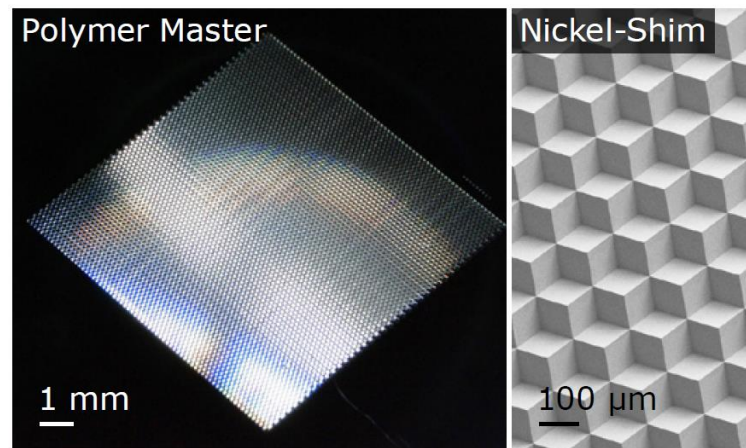
Industrielle Anwendung: Mikrooptik

Replication methods

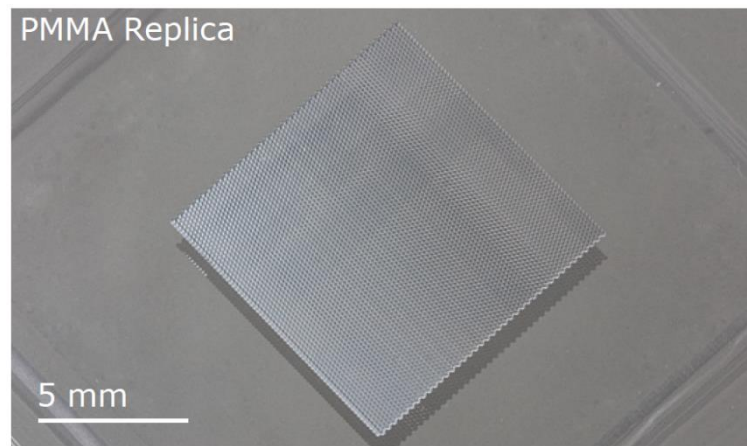
**Direct hot
embossing**



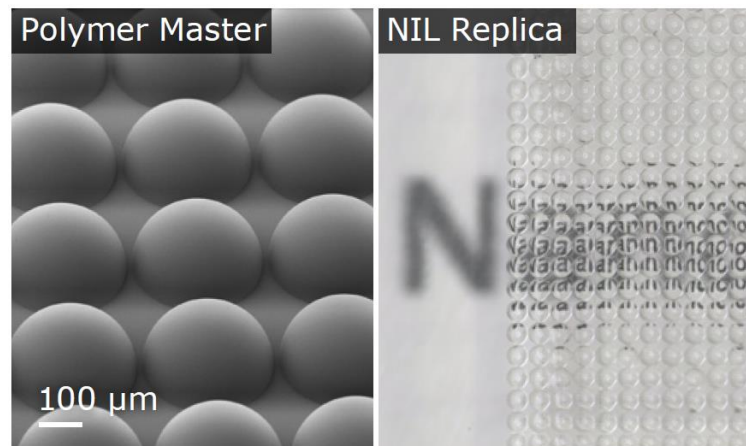
**Hot embossing
via Ni shim**



**Injection
molding**



**Nanoimprint
lithography**





High Precision 3D Printing Solutions

Thank you for your attention!

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