

# Hot Lithography

high precision 3D-printing  
of tough and temperature resistant photopolymers

Dr. Robert Gmeiner

Zwick/Roell TestXpo, Ulm, 18.10.2017

# Additive Manufacturing

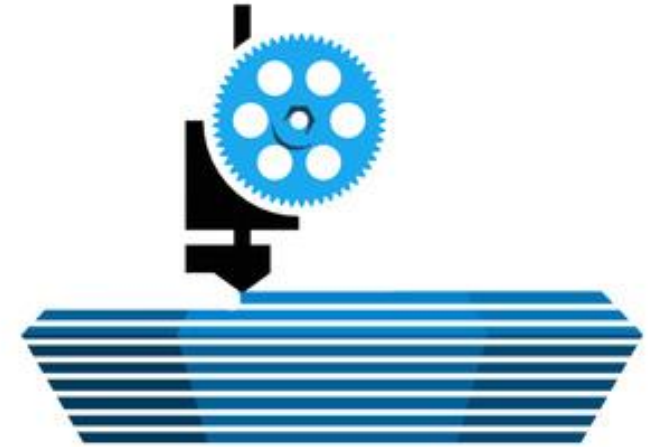
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**3D-model**



**slicing**



**layer-by-layer build-up  
in a 3D printing setup**



# What the industry really needs!

**Additive manufacturing of functional polymer parts with highest precision**

prototypes,  
design objects,  
functional  
samples

*functional parts for technical applications*



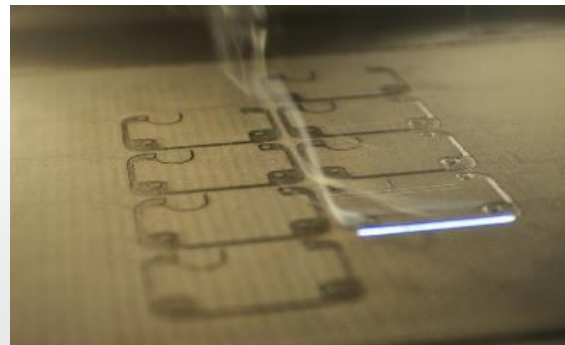
# 3D-Printing of polymers



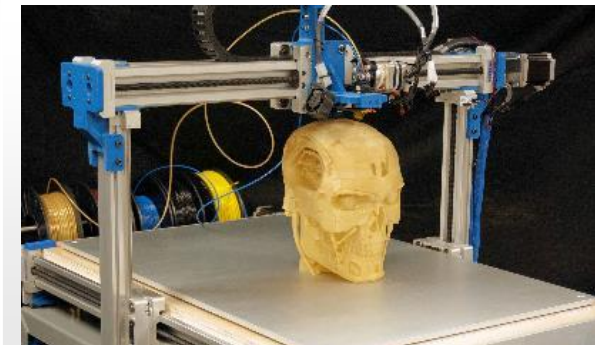
3D-Printing



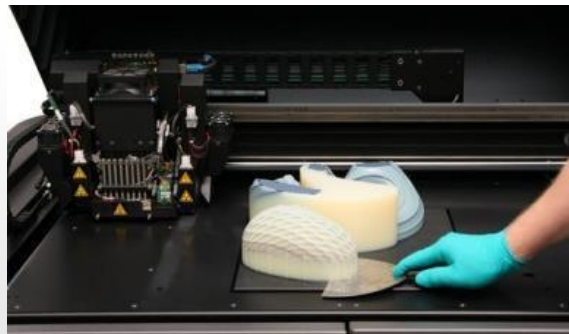
SLS



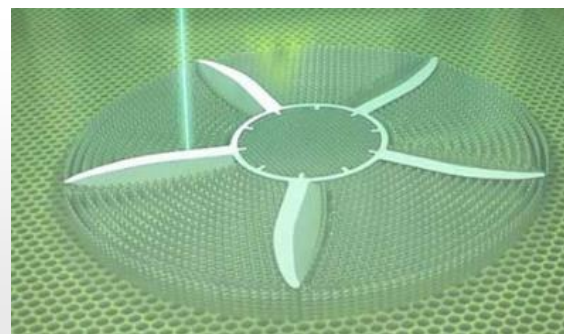
FDM



Inkjet



Stereolithographie (SLA, DLP)





# Dilemma of 3D Printing

	Geometry	Material	Economics
Selective Laser Sintering	~	✓	✗
Fused Deposition Modeling	✗	✓	~
Inkjet Photopolymers	✓	✗	✓
Stereolithography	✓	✗	✓



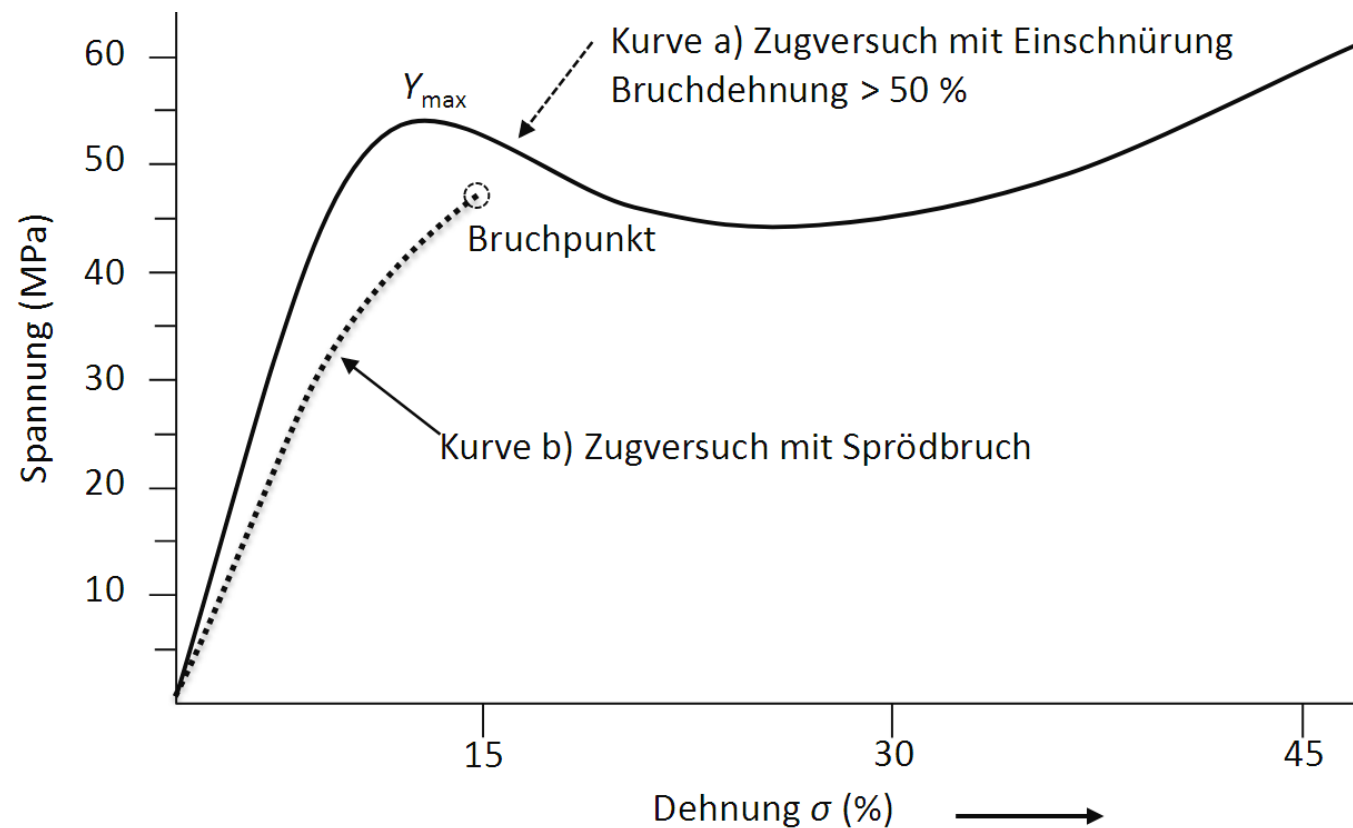
# Injection molding quality needed!

**Precision**

**Stereolithography**

**Mechanical properties**

**Thermoplasts**





# New material & process concept

## Development of the Hot Lithography technology

Combination of  
photopolymers and  
thermoplasts

Material

- Development of new materials
- High temperature + photopolymerization

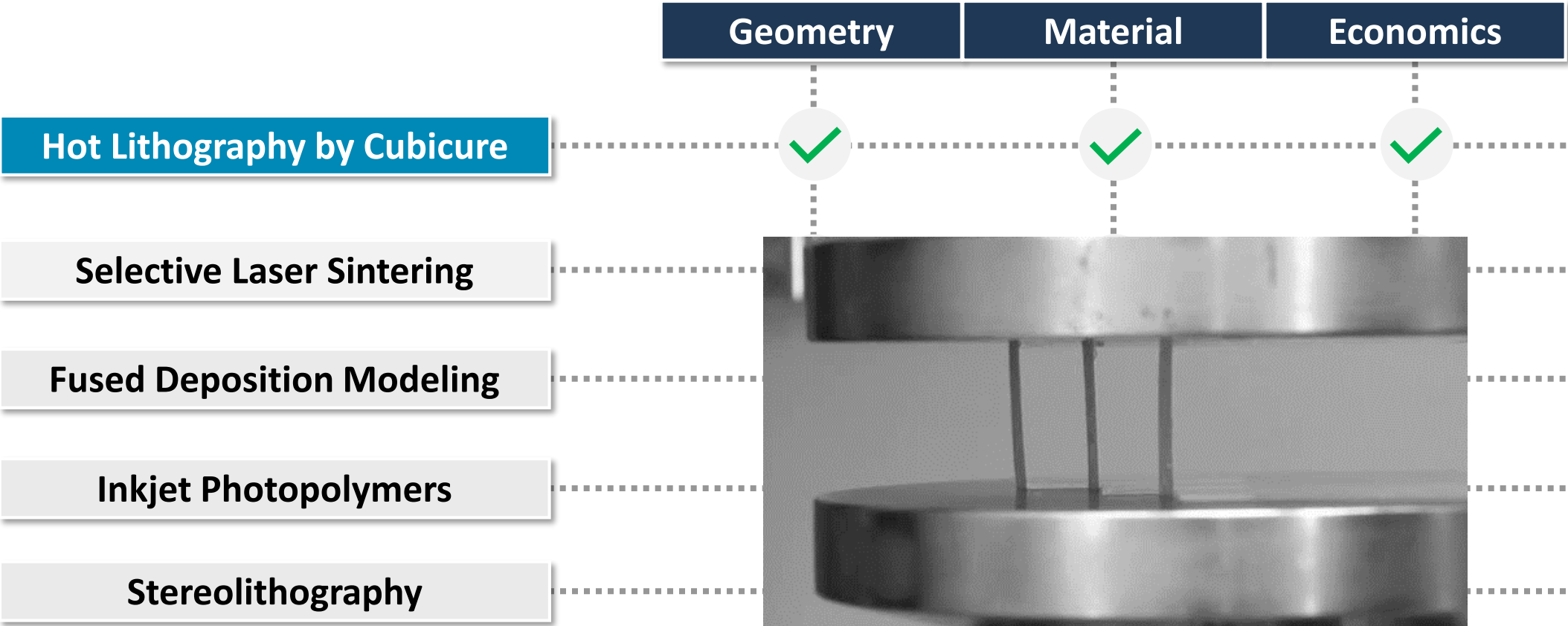
New printing technology  
needed

Process

- Heated process area
- Material coating mechanism



# Dilemma of 3D Printing

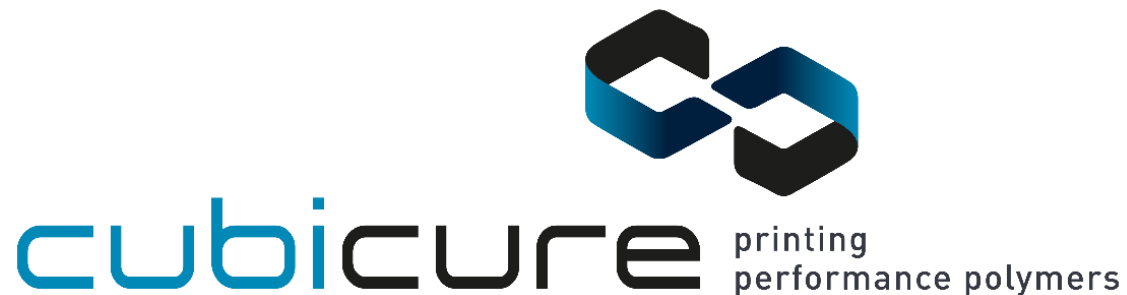






# Cubicure GmbH

Lithography-based additive manufacturing of polymers for technical applications

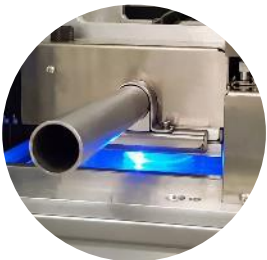


## Spin-Off of TU Wien (2015)

> 8 years of experience in lithography-based 3D-printing

## Infrastructure

11 employees  
100 m<sup>2</sup> chemical laboratory  
380 m<sup>2</sup> office and shop floor



additive manufacturing systems



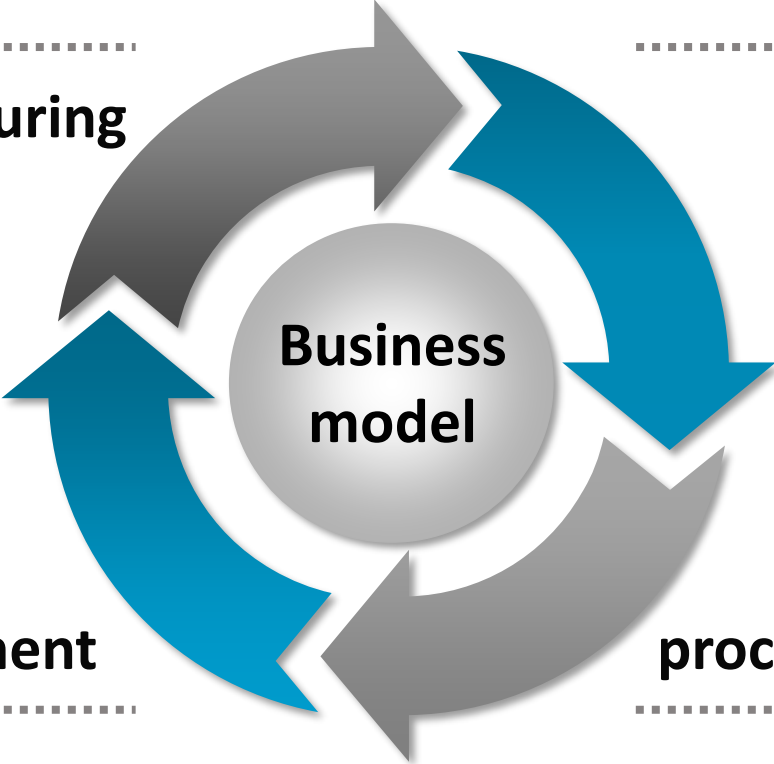
innovative resins



material development



process development



# Shareholder

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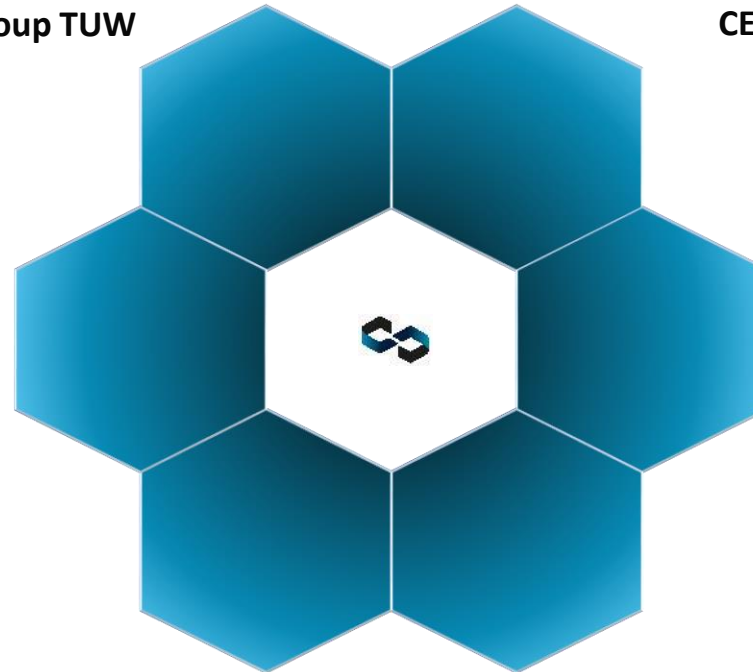
**Prof. Jürgen Stampfl**  
Head of AMT group TUW



**Dr. Robert Gmeiner**  
CEO, Cubicure GmbH



**Dr. Johannes Homa**  
CEO, Lithoz GmbH



**Prof. Robert Liska**  
Organic technologies TUW



**Dr. Hans Langer**  
EOS e-Manufacturing Solutions

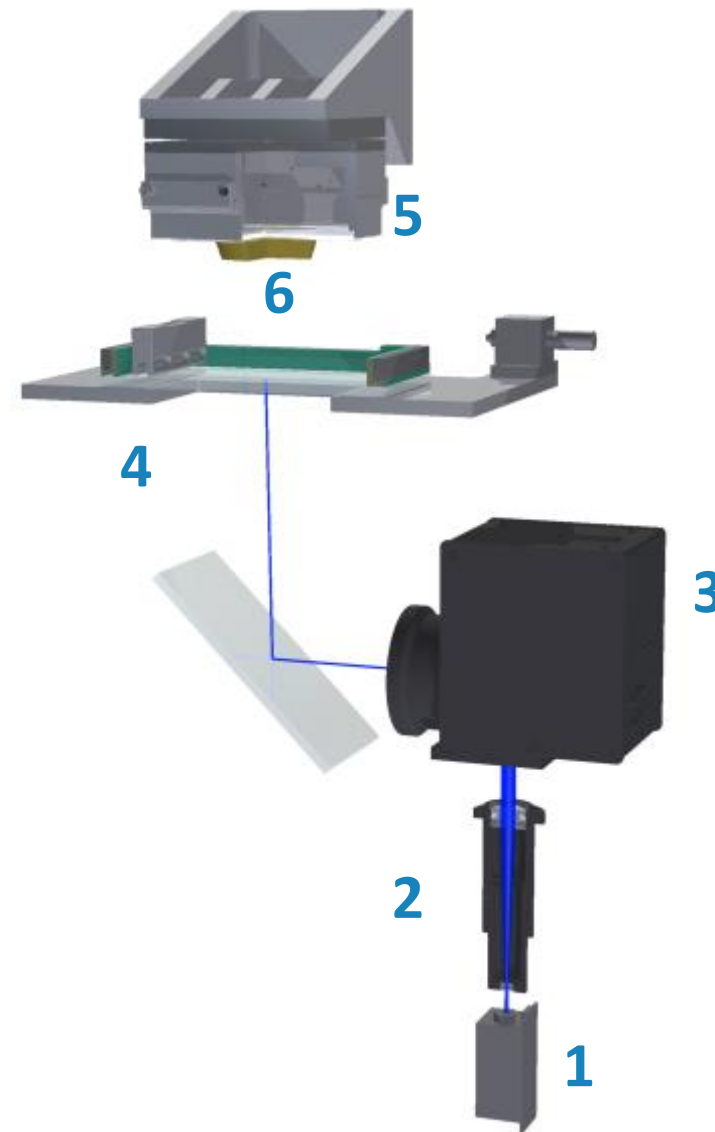


**DI Johann Oberhofer**  
CEO, AMB GmbH

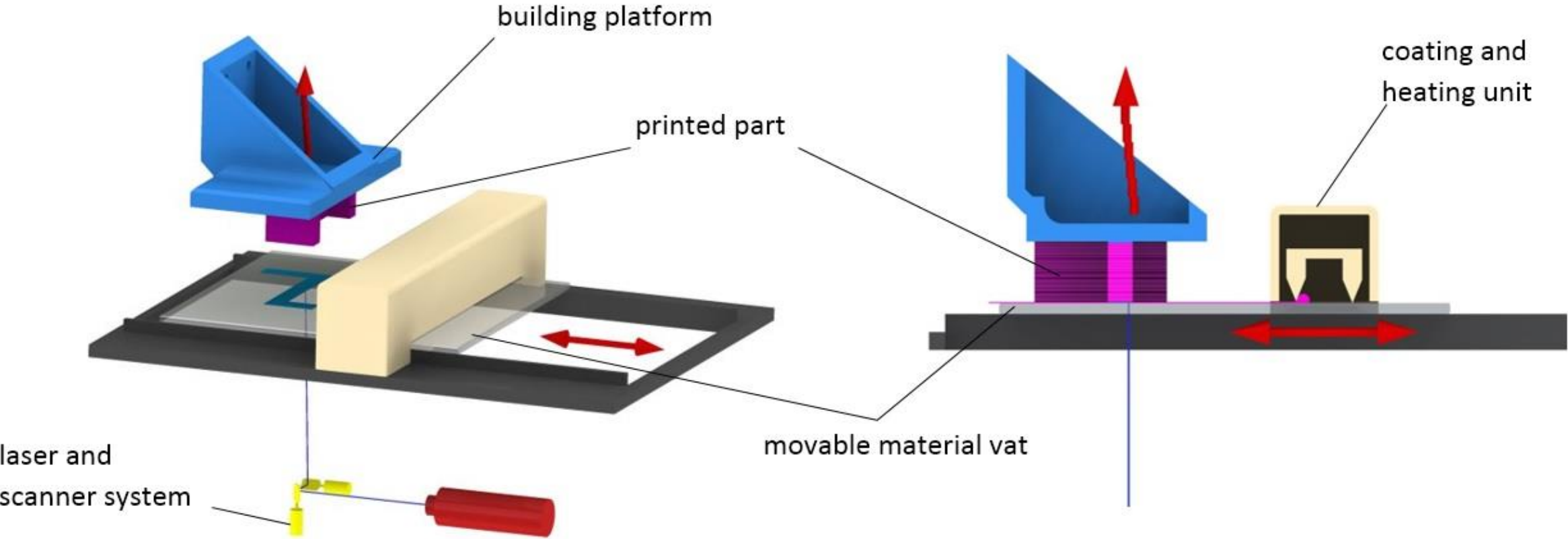


# Lithographic 3D-printing

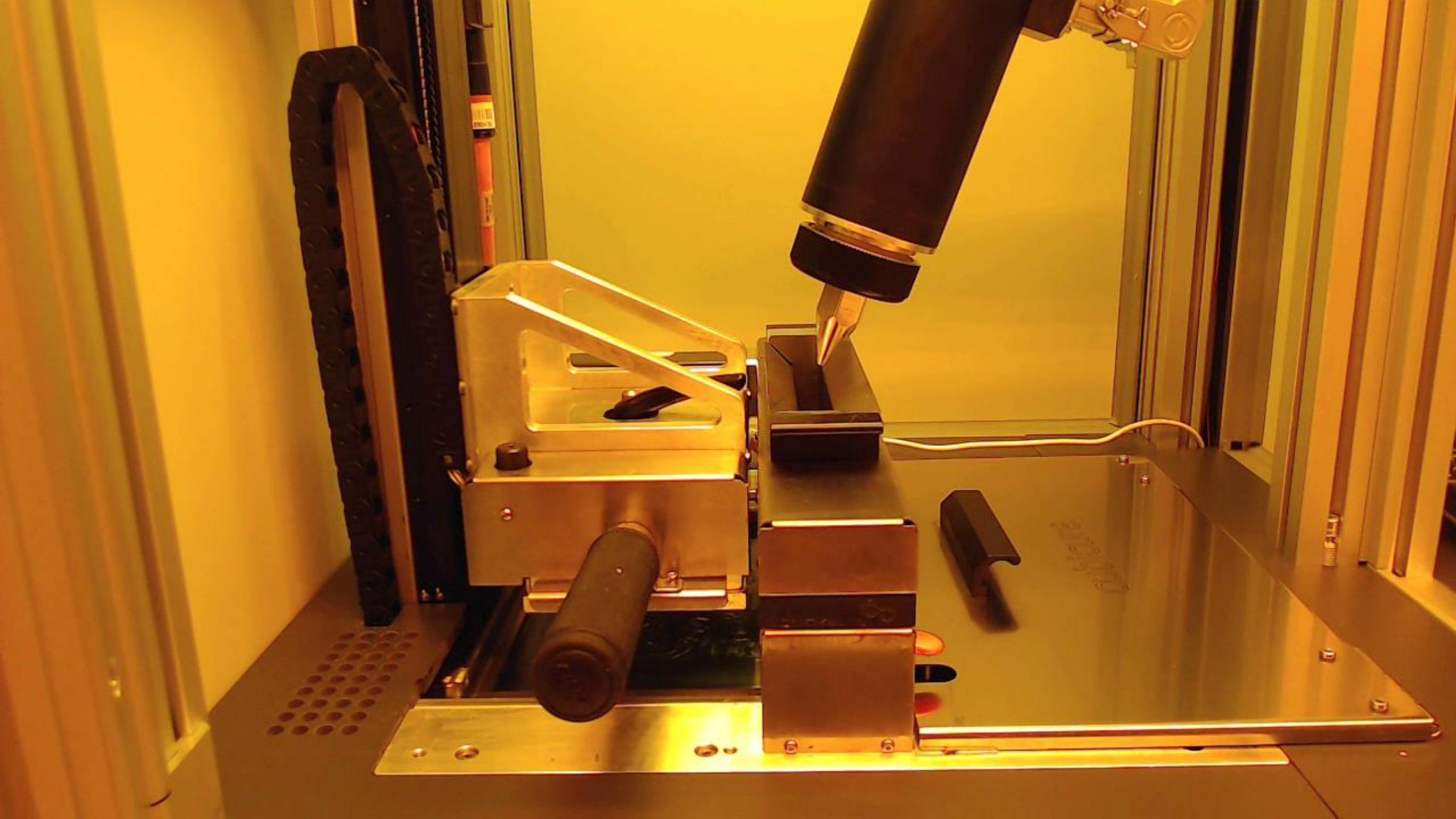
- 1 Laser light source
- 2 Optical system
- 3 Scanning system
- 4 Coating system
- 5 Building platform
- 6 Printed part



# Hot Lithography







# Hot Lithography



New, patented technology

High viscous resins



process heating, highest precision

good thermo-mechanical properties



# HL Manufacturing System

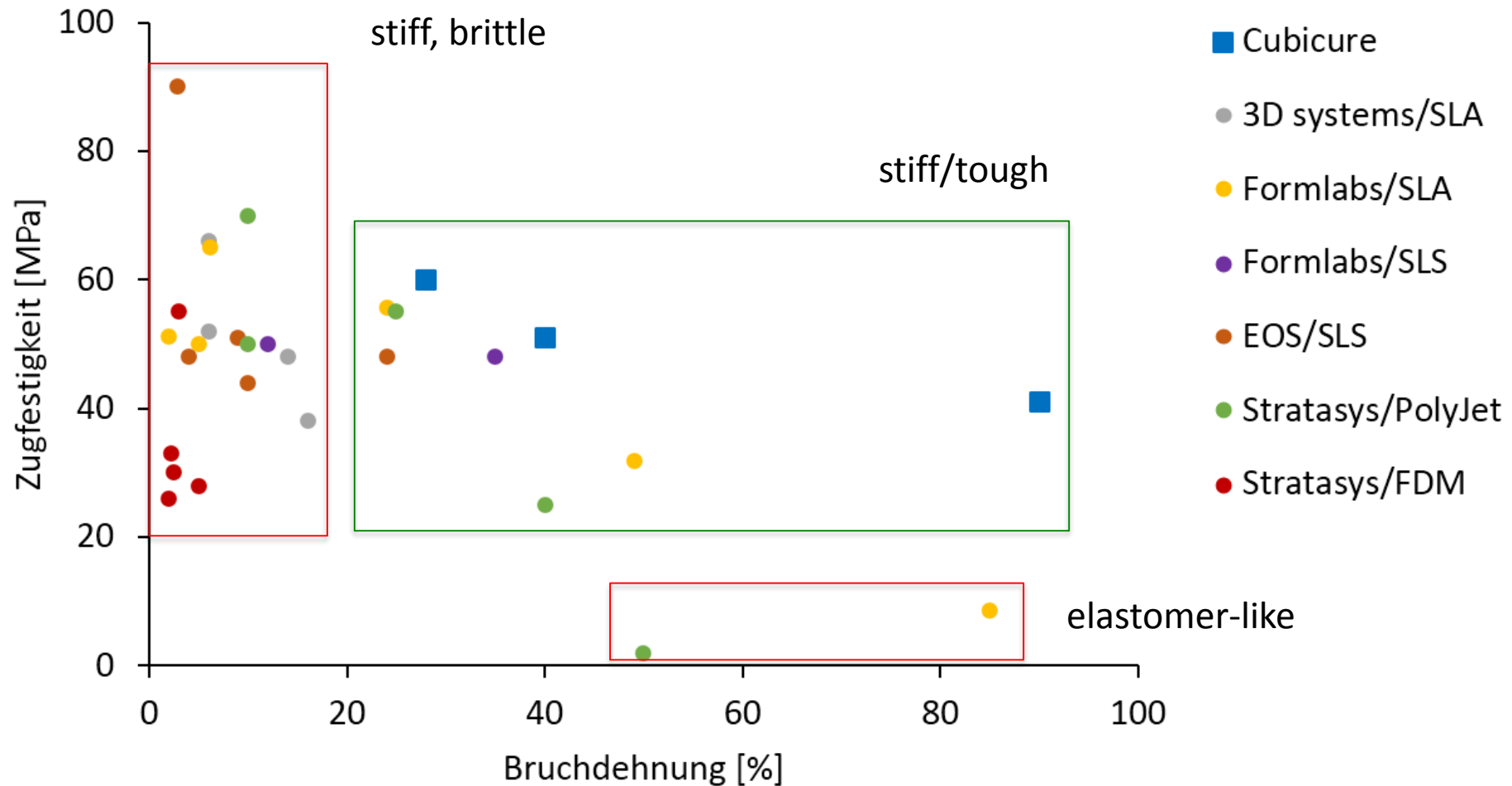
## Caligma 200

- Hot Lithography technology (up to 120°C)
- Cubicure photopolymers
- conventional photopolymers
- laser system (wavelengths of 375 or 405 nm)
- resolution: 10 to 100  $\mu\text{m}$
- building envelope: 200 x 100 x 300 mm<sup>3</sup>

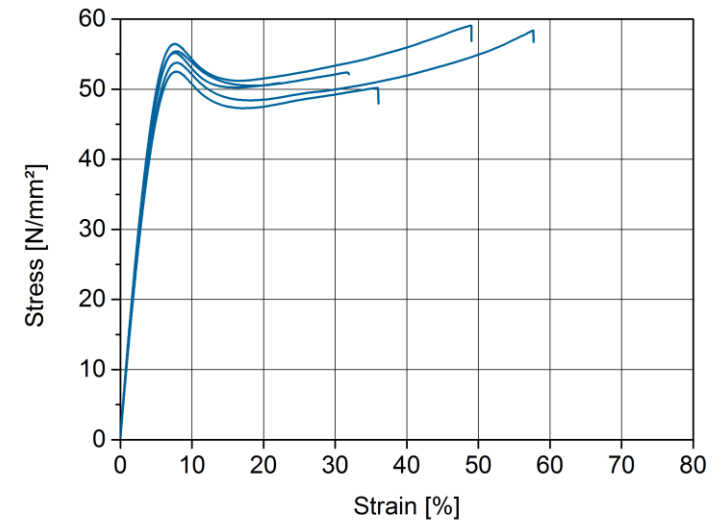
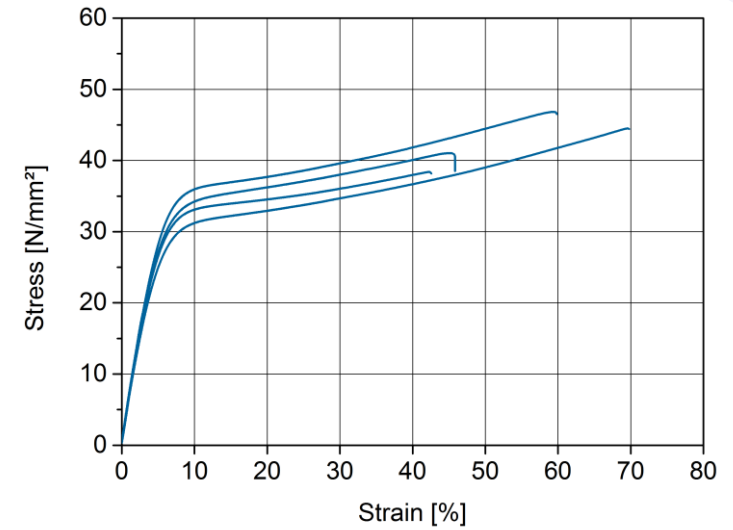
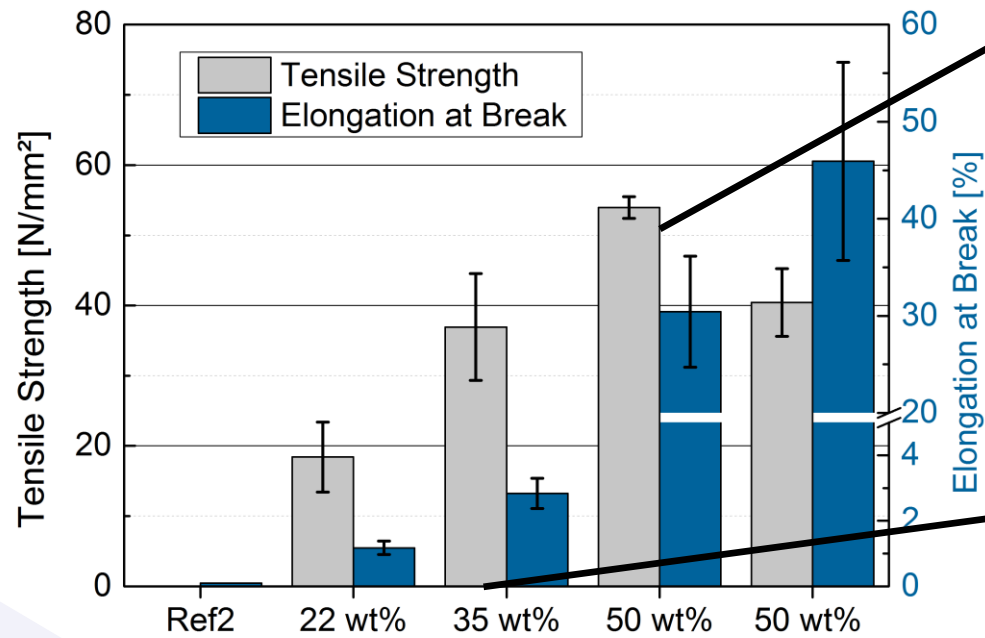
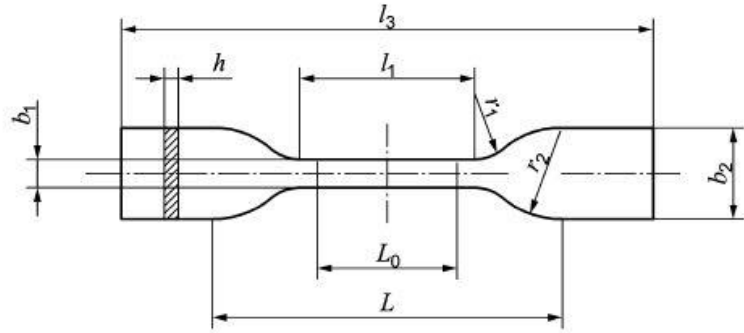




# Material development



# Material development

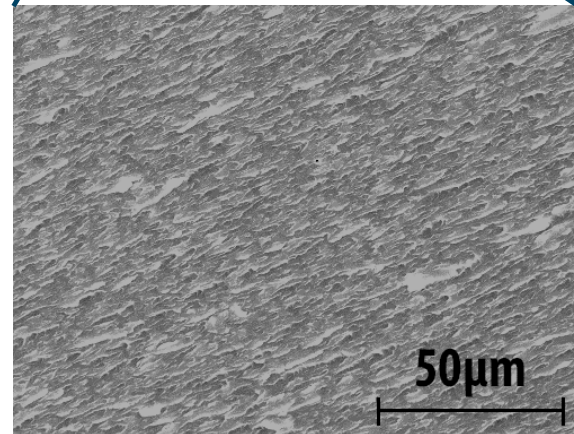
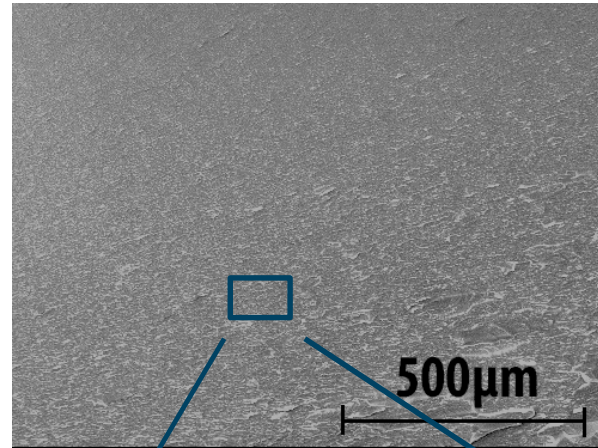


# Material development



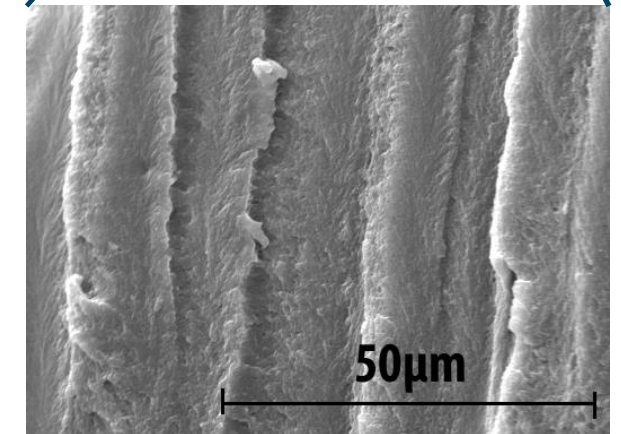
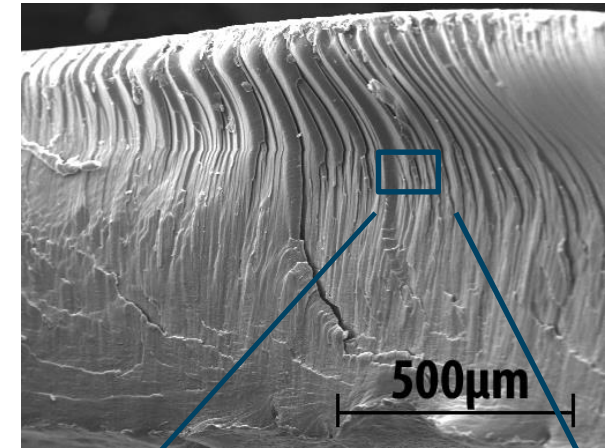
## brittle fracture:

conventional photopolymers

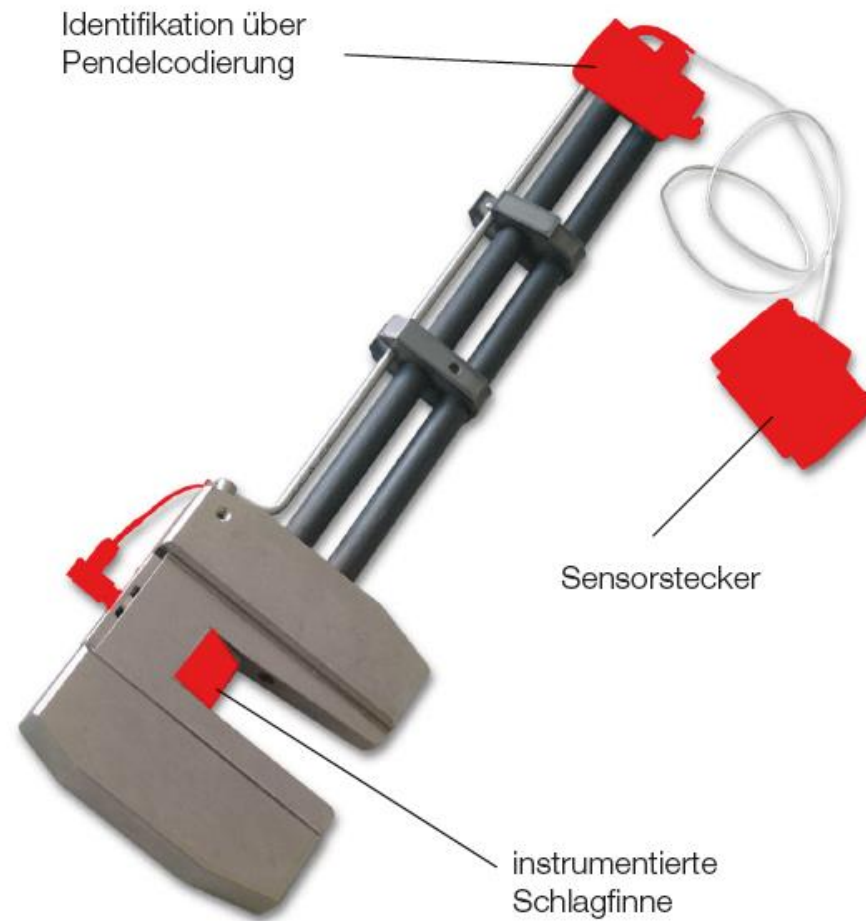


## ductile fracture:

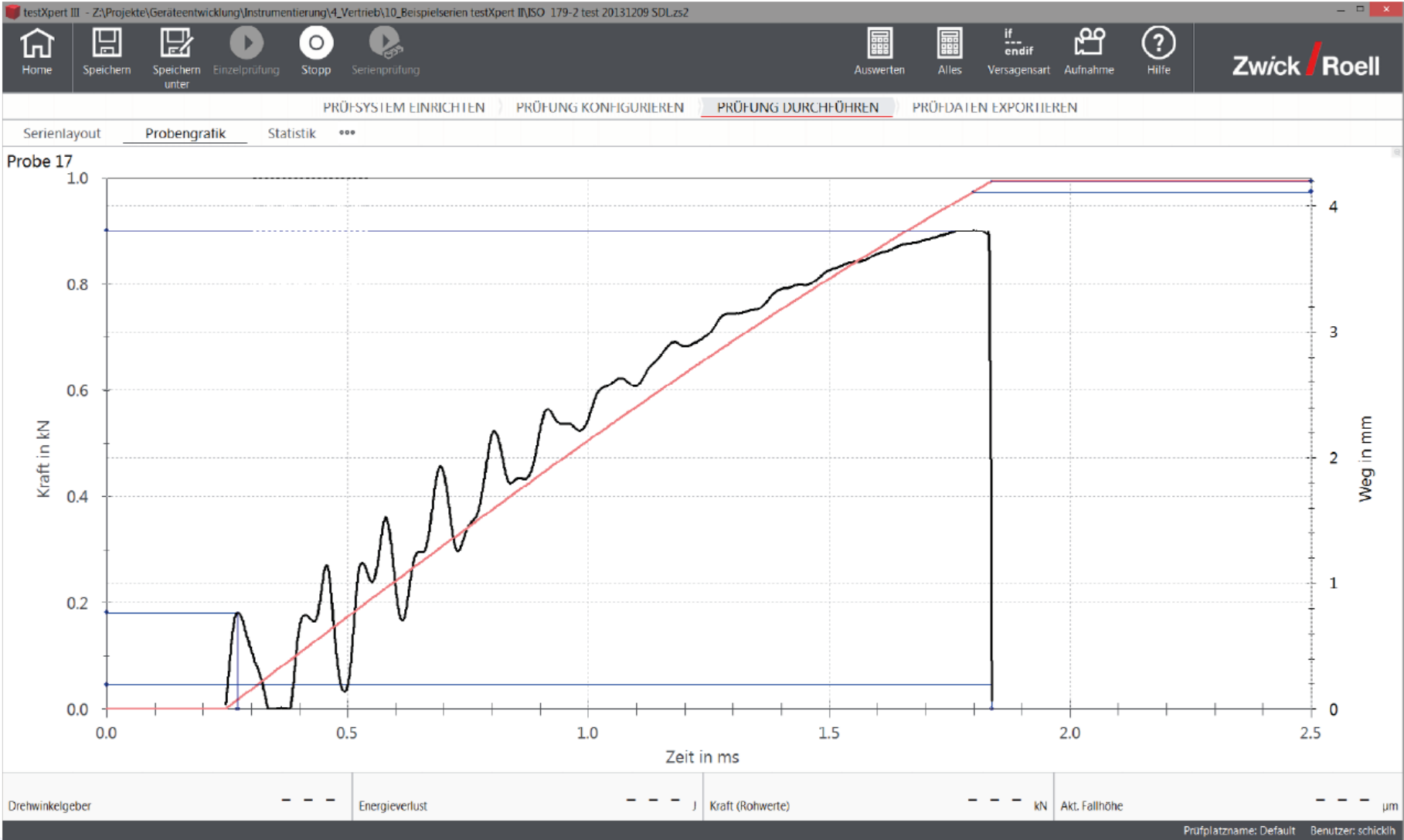
Cubicure materials



# Material testing



# Material testing





# Engineering parameter

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## Material parameter

Strength:	35-55 MPa
E-modulus:	1,5-4 GPa
Toughness (Charpy):	30-120 kJ/m <sup>2</sup>
Elongation at break:	20-100 %
Temperature resistance:	100°C

## Process parameter

Laser focus (x,y-res.):	10-100 μm
Layer thickness (z-res.):	10-100 μm
R <sub>a</sub> value (average):	< 2 μm
R <sub>z</sub> value (average):	< 12 μm





# Material testing

Classification according to ÖVE/ÖNORM EN 60695-11-10:

**Flammability class HB 40**

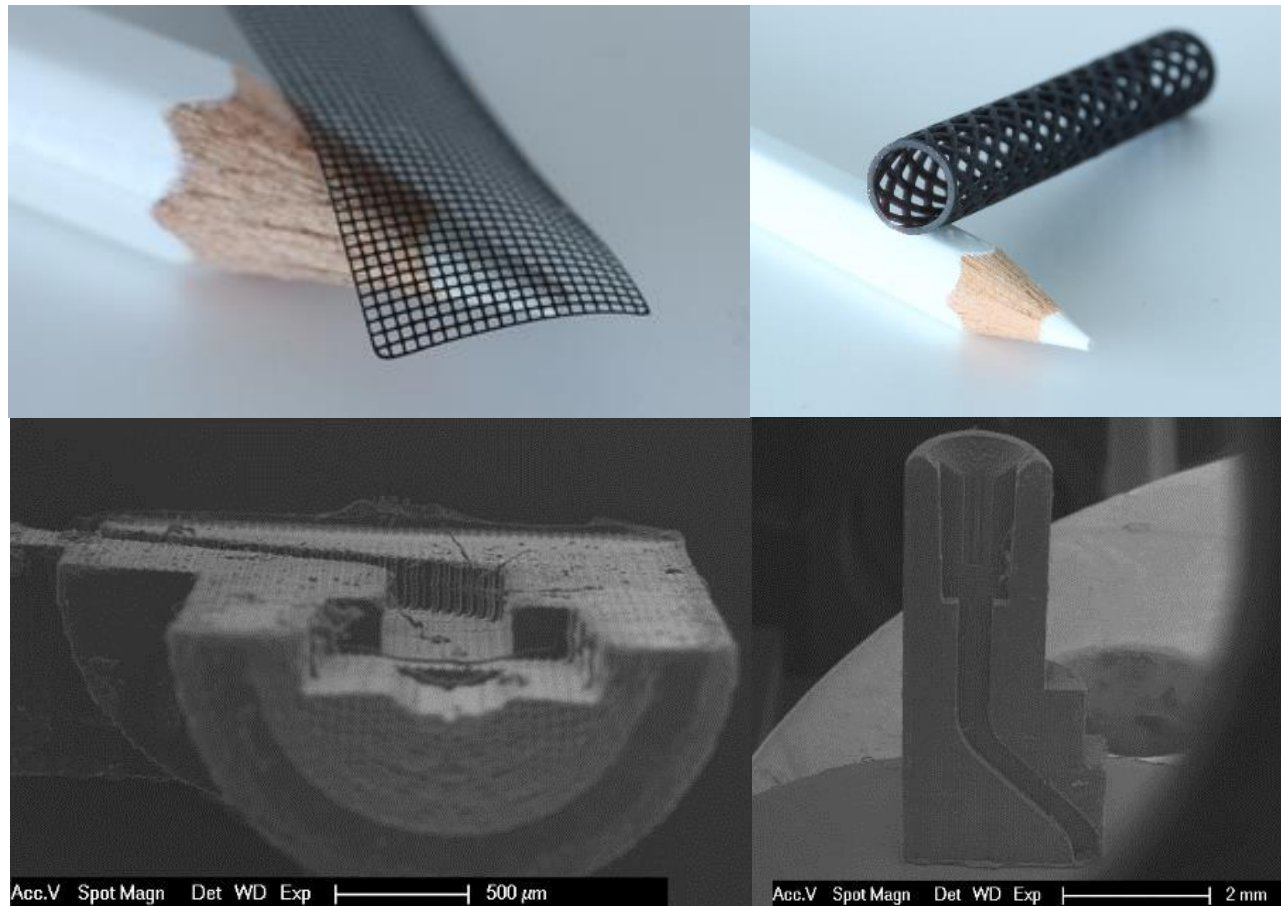
Specimen thickness: 1,34mm





# Functional prototyping

- Highest precision
- Fine structures, details
- Unlimited complexity
- Individualization





# Functional prototyping



5 mm

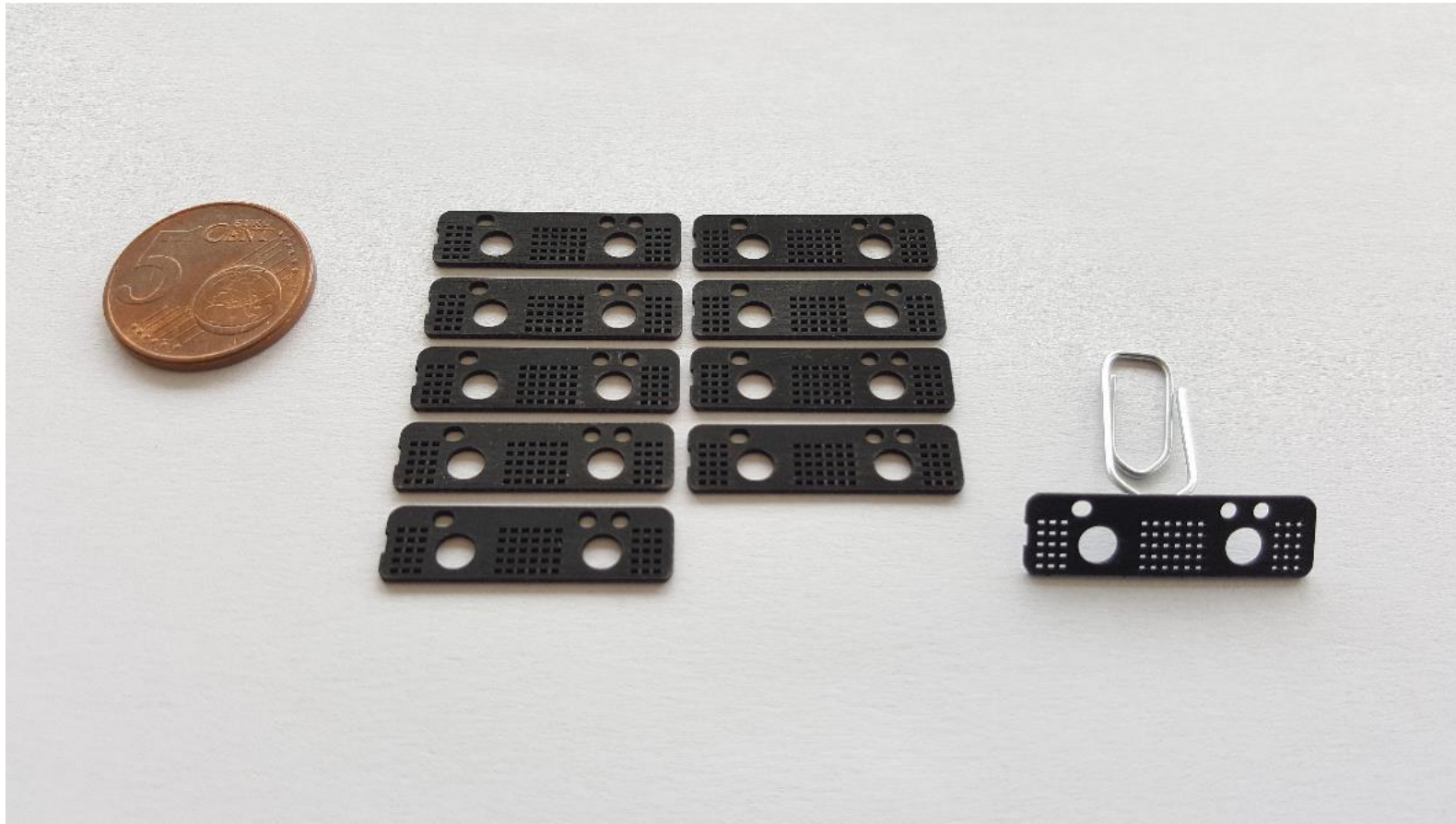
Colored Cubicure Photopolymer



10 mm



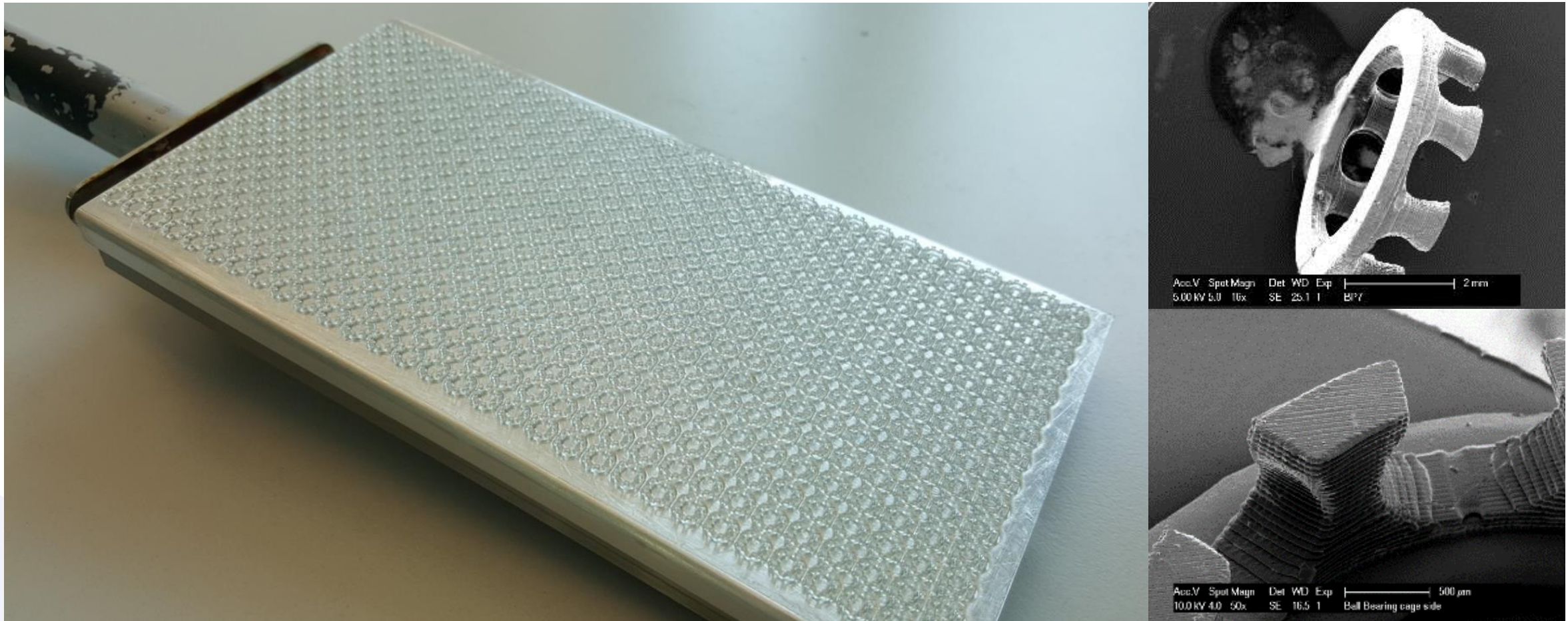
# Functional prototyping & small series



# Series production



465 ball bearing cages in 2,5 h







# Case study

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## Sample carrier

### Requirements:

- 100 pcs.
- Geometry
  - Sample holding mechanism
  - Filling / Defilling
- Material
  - cleanable (smooth surfaces, dish washer at 60°C)
  - Crack resistant (drop height 1,5 m)
  - Reusable/durable





# Case study

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## How to manufacture?

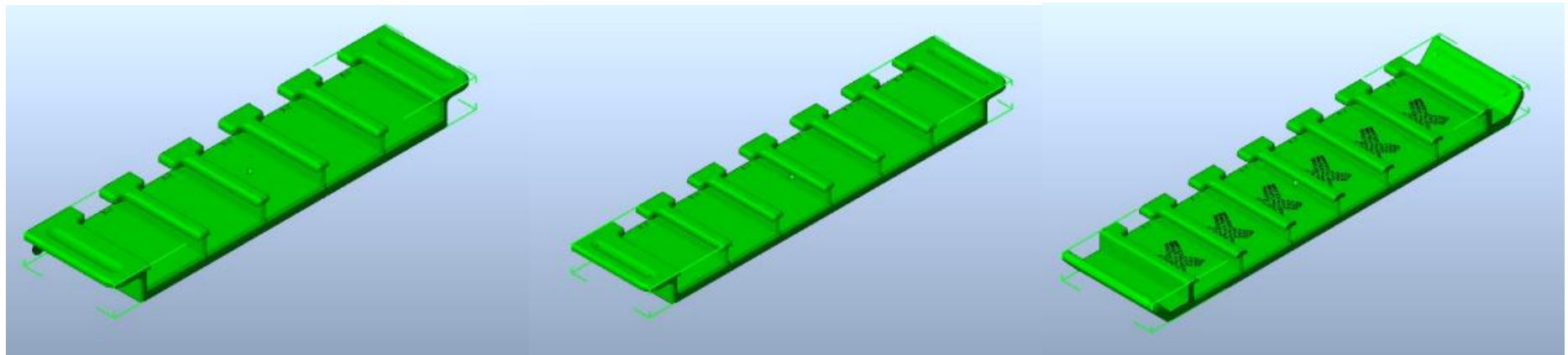
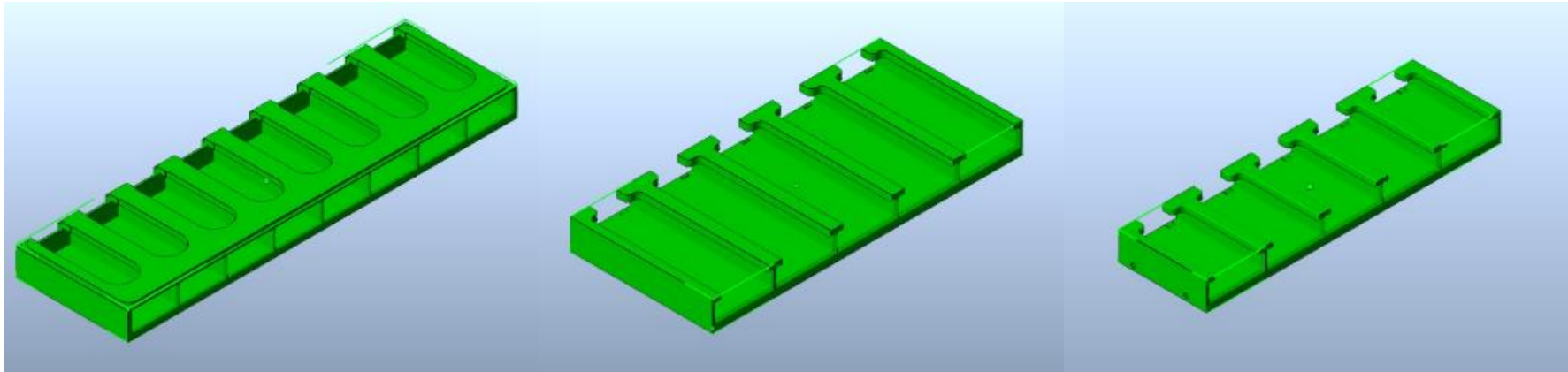
- Injection molding                      100 pieces?
- FDM    surface, precision?
- Multijet Modeling                      60 °C + tough?
- Stereolithographie                      60 °C + tough?
- Laser sintering (SLS)                      surface?
- Hot Lithography

# Case study

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## Design iterations

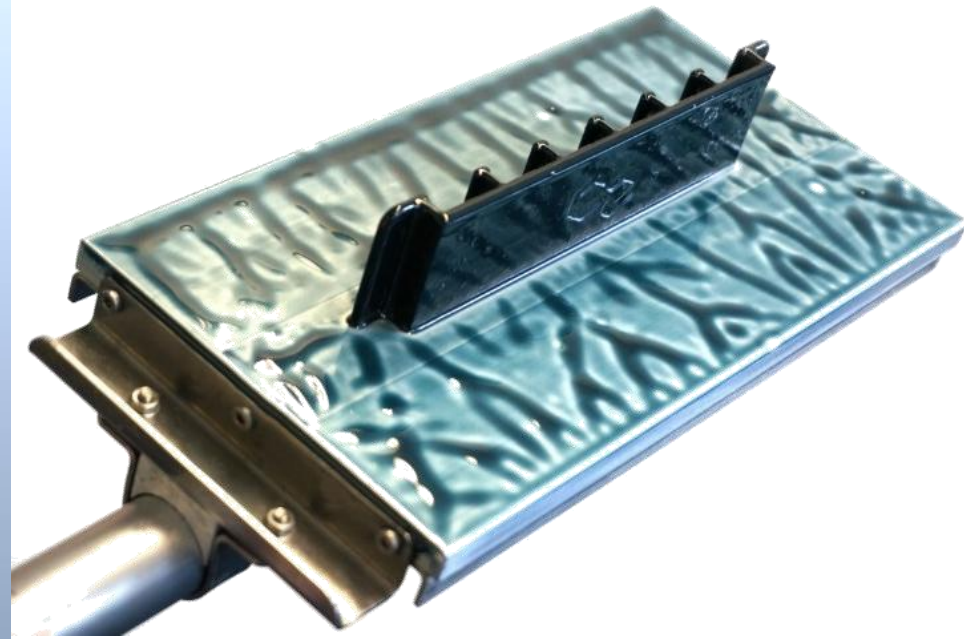
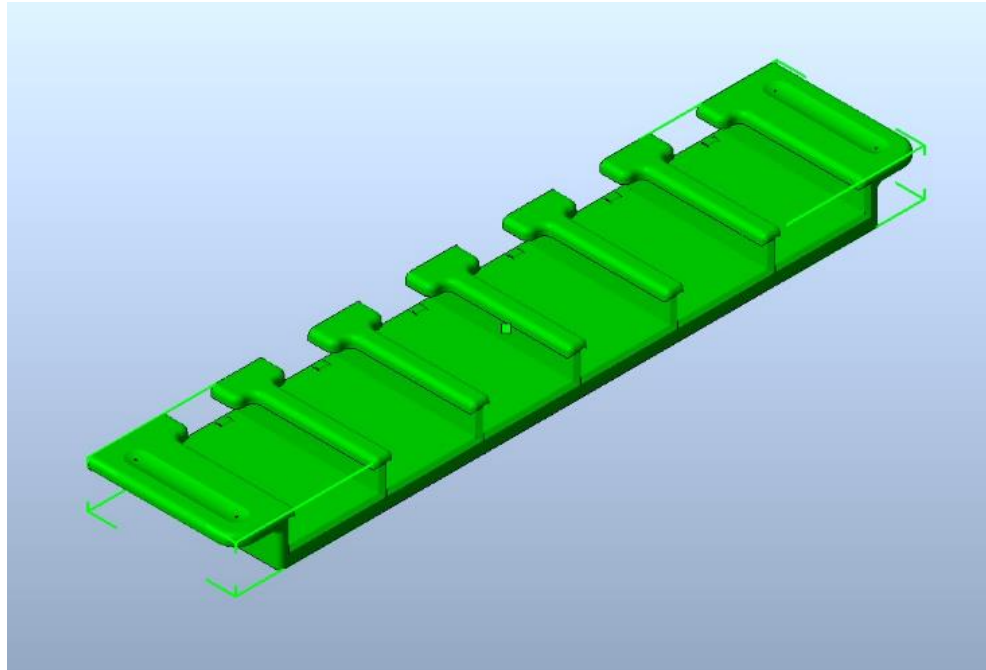


# Case study

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1 design = 1 functional prototype

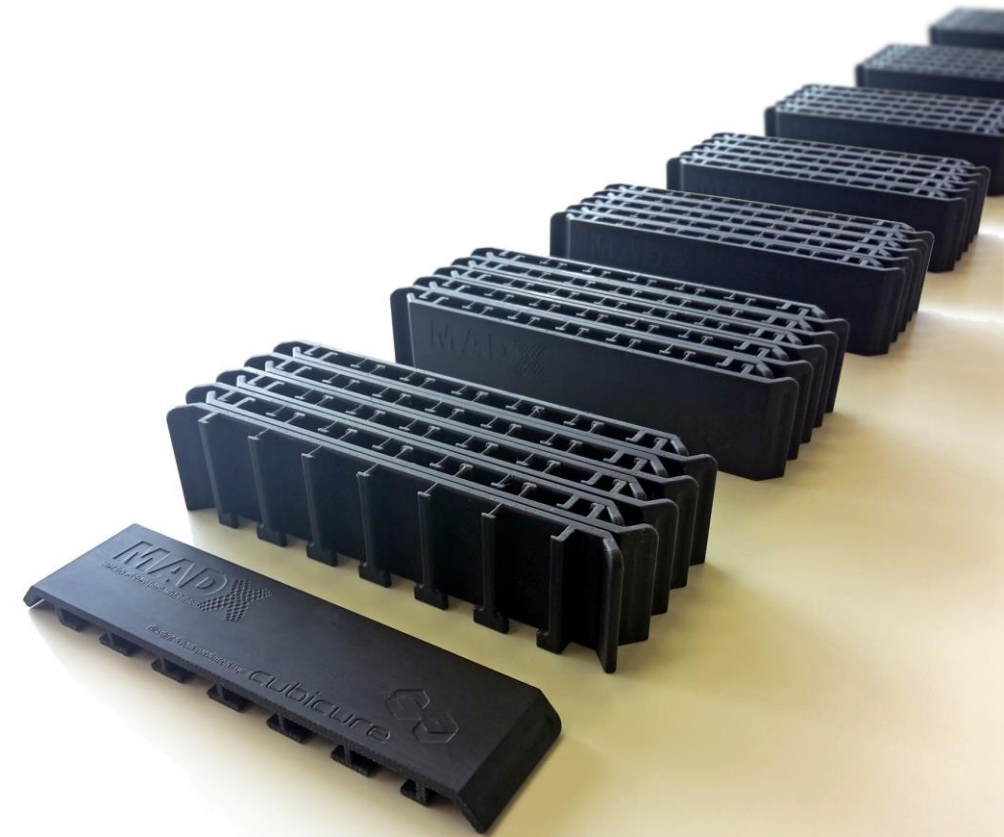
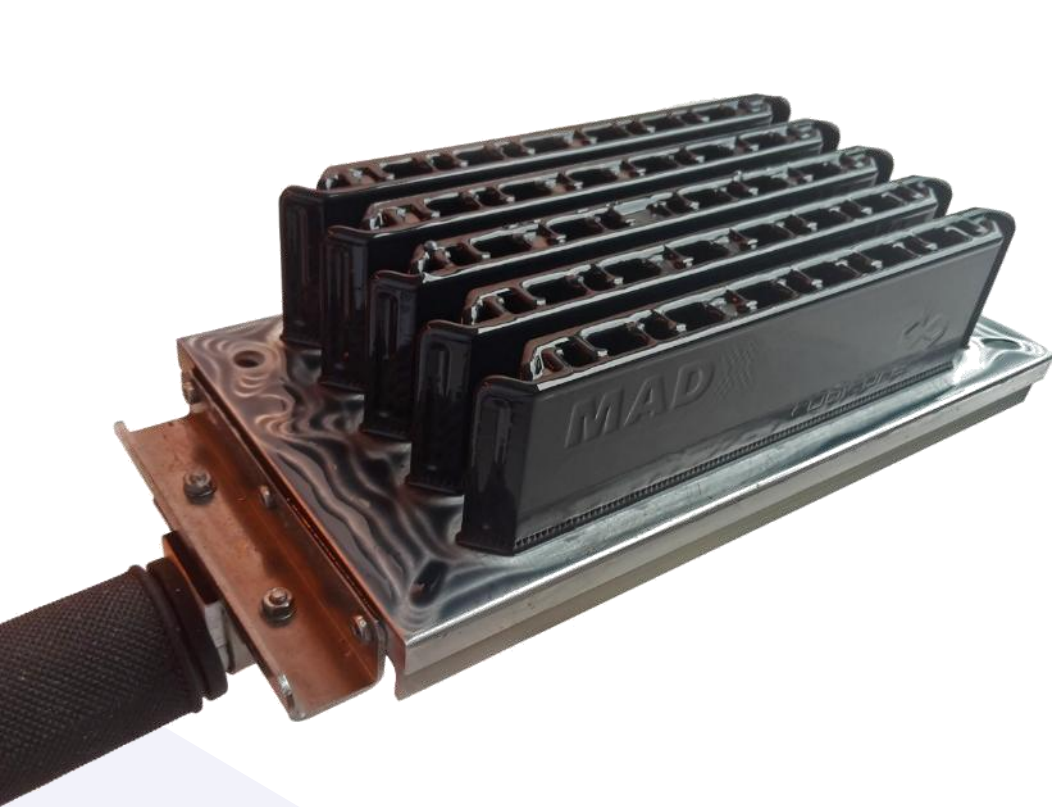


# Case study

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**Scalability: prototyping = pre-series or series production**

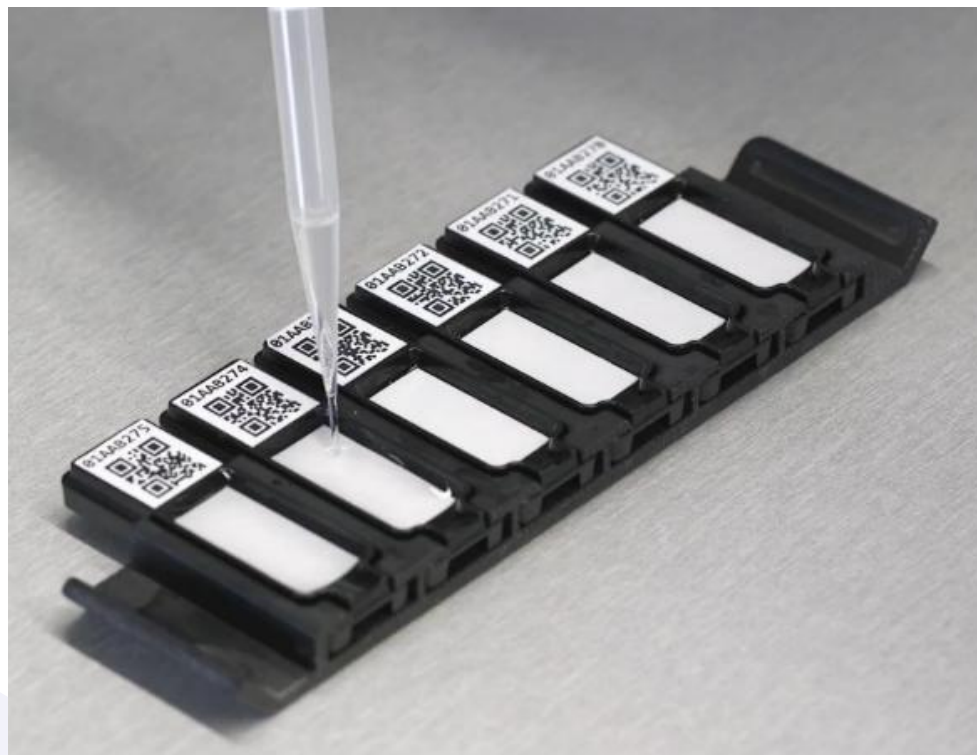






# Case study

## Final product made by Hot Lithography





# Case study 2

## Spare part logistics: Acces key for car parking system

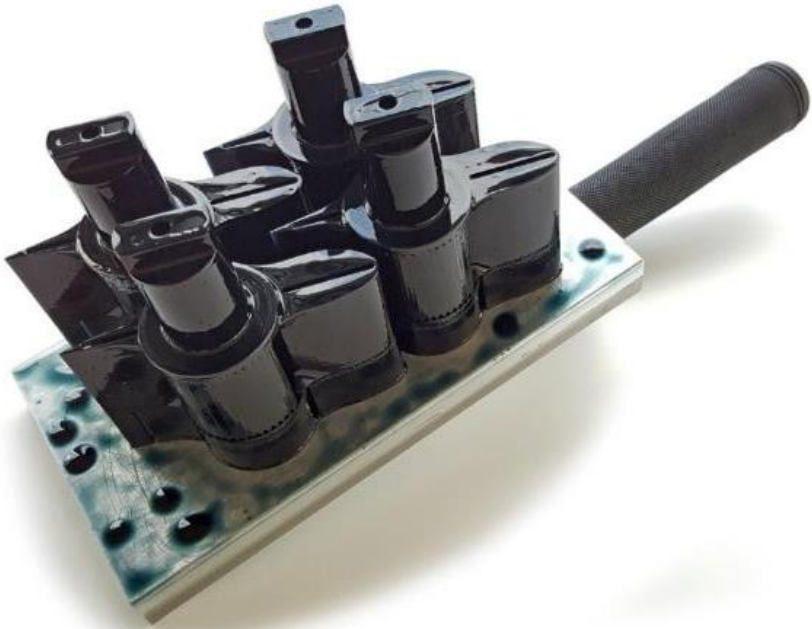




# Case study 3

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## Turbine blades for prototype test stand





# Awards



- Science to Business Award 2015 (S2B)  
Rudolf Sallinger Fonds
- Mercur Award of Vienna chamber of commerce; Start-Up Star 2016



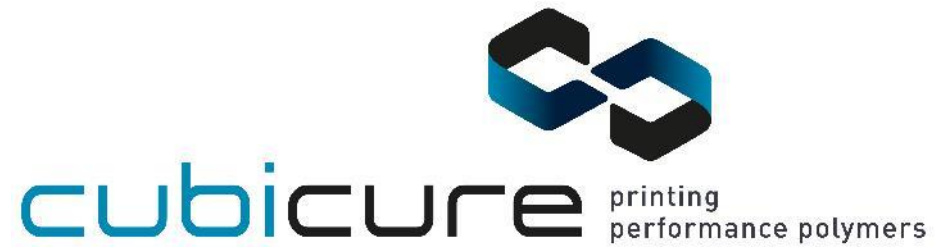


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