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# Fraunhofer Kompetenzfeld Additive Fertigung

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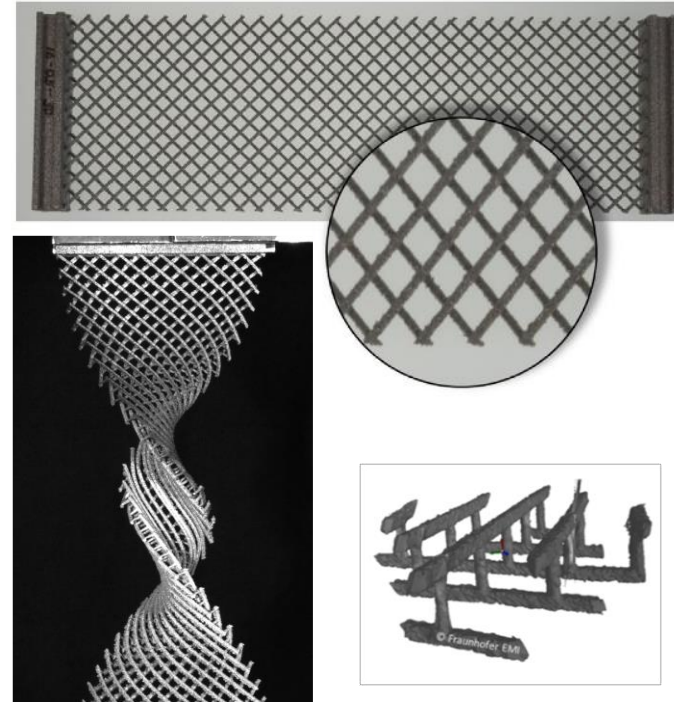
# Design funktionaler Materialien

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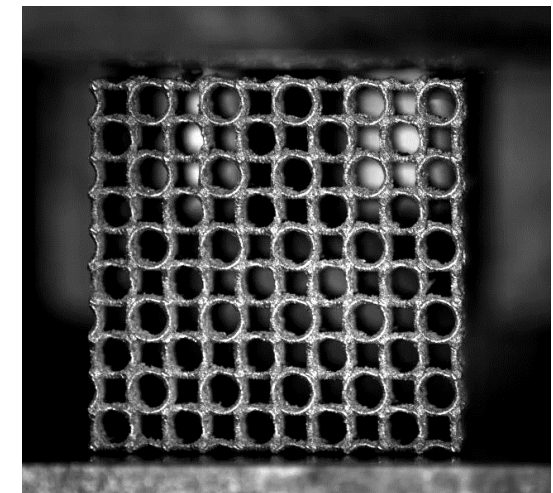
## Metallic mechanical Metamaterials

### Mechanical Metamaterial

- Development of metamaterials with properties that do not normally occur in nature.
- E.g. negative Poisson's ratio, high elastic deformation, bistability
- Macroscopic "material behavior" is determined by inner structures at microscopic or mesoscopic level
- Assembly of geometrical unit cells



Pantographic Metamaterial made of an aluminum alloy by SLM.



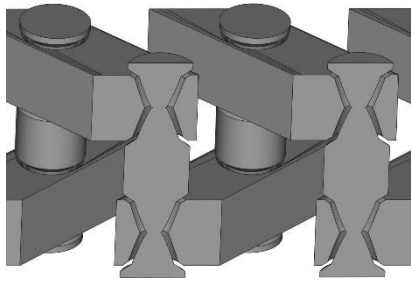
Metamaterial with negative Poisson's ratio during compression test.

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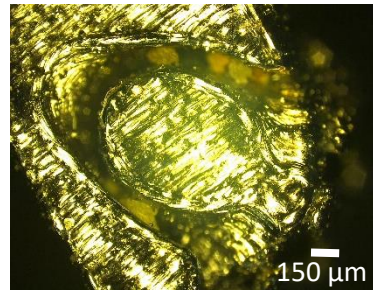
Opportunities and strategies in the design of programmable metallic metamaterial by AM

## Multi-body systems

- Printing of multi-body systems , eg. hinges or guidance



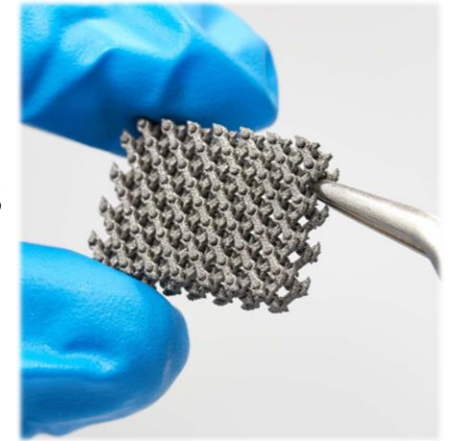
Pantographic lattice structure with hinges



Microscope image of a 3d printed hinge

## Filigree functional structures

- Printing filigrane structures by L-PBF
- Combinable with multi-bodies
- ~300 µm structures
- > 99 % relative density



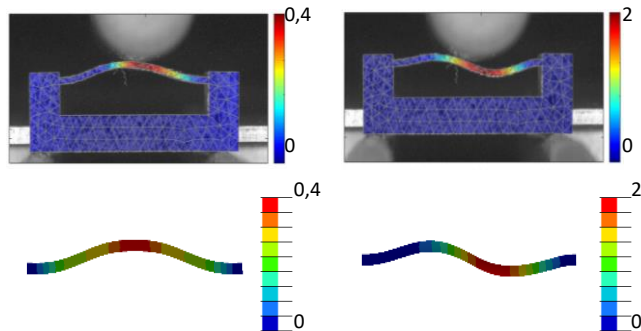
Filigree pantographic structure

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## Example: Two Different Strategies for Metallic Metamaterial with Bistable Behavior

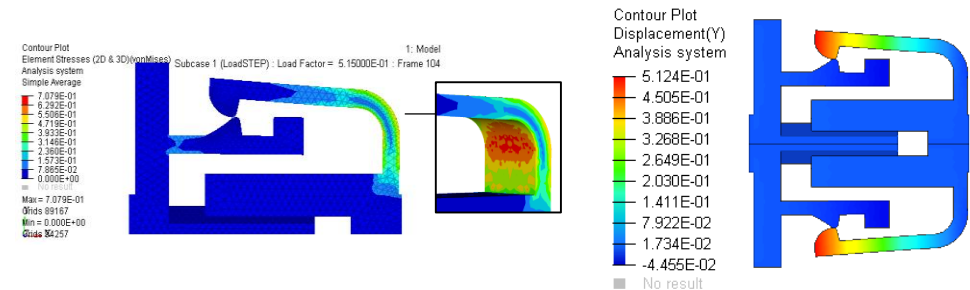
### Monolithic structure

- Metamaterial with **snap-through mechanism** to enable two stable states
- Use of pseudo-elastic base material to enable high elastic deformation
- Printing of filigree structures



### Multi-body structure

- Metamaterial with **snap-In mechanism** to enable two stable states
- Use of elastic-plastic material with limited elastic deformation (Ti6Al4V)
- Direct manufacturing of multi-body structures
- Printing of filigree structures

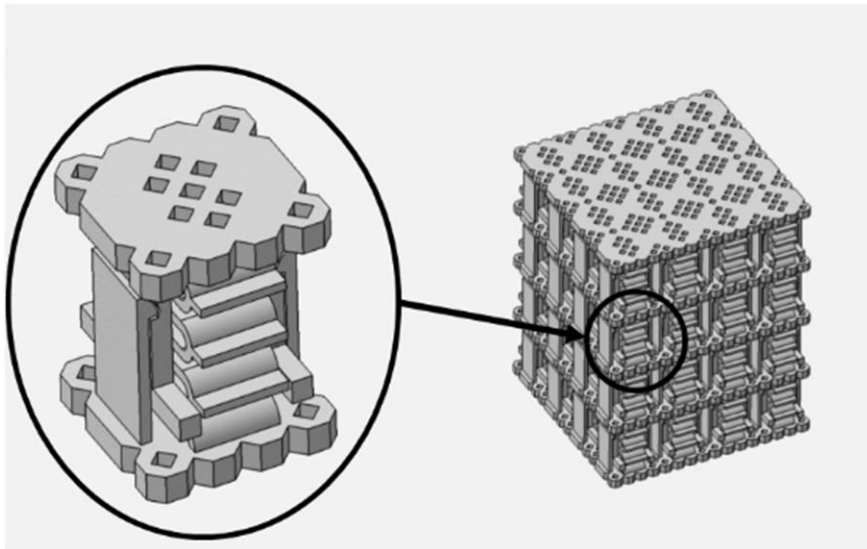


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## Example: Upscaling of Unit-Cells and Metamaterial Assemblies

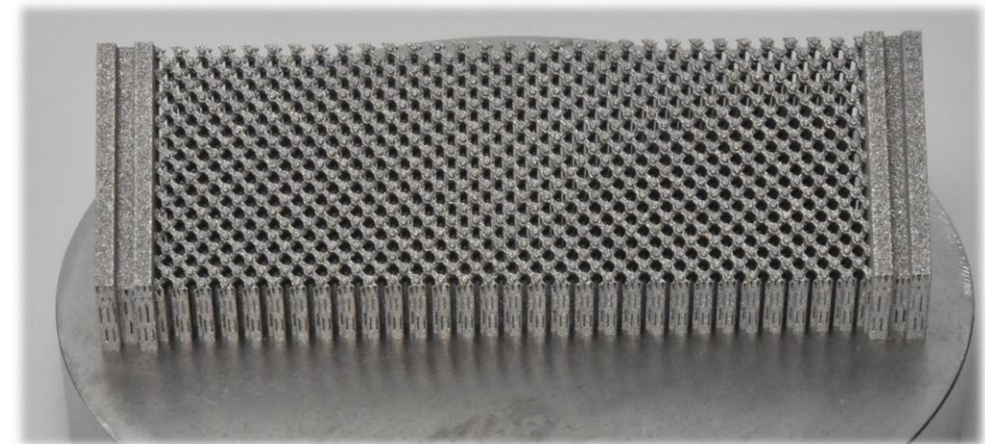
### Quasi-Multi-body assembly

- Design adaption of the **snap-In mechanism** to optimize printability as an assembly
- Spring width and snap-In structure width can be varied to program the material



### Multi-body pantographic structure

- Assembly of over 100 separate bodies
- Stiffness variation of the hinges (flexure bearing to real hinges) allow programmable deformation



# Kontakt

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