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BAM
Bundesanstalt für Materialforschung und -prüfung

Sicherheit in Technik und Chemie

13.09.2018

COMPUTED TOMOGRAPHY OF SLM PRODUCED IN625 PARTS: FROM POWDER GRAINS TO LATTICE STRUCTURES

T. Thiede[1], L. Farahbod[2], F. Léonard[1], I. Serrano[1], G. Bruno[1]

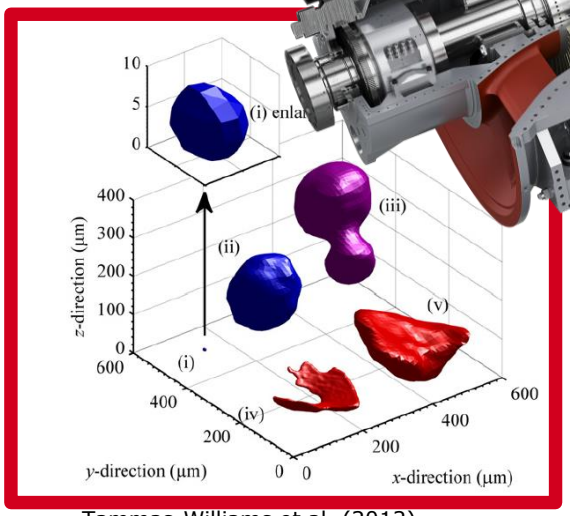
[1]BAM – 8.5 Mikro-ZfP
[2]Siemens AG, Power and Gas

www.bam.de

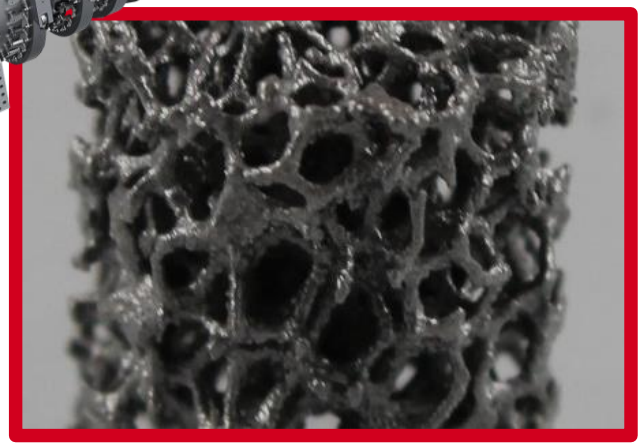
Motivation

http://resources

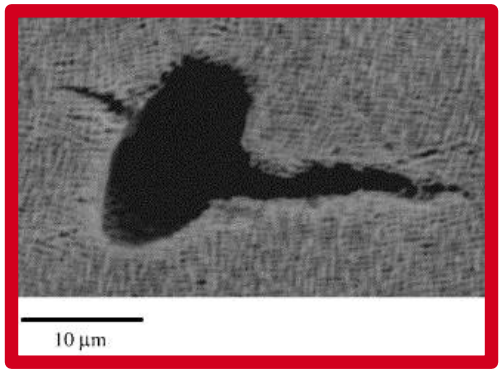
https://www.3yourmind.com/blog-de/



Tammas-Williams et al. (2012)

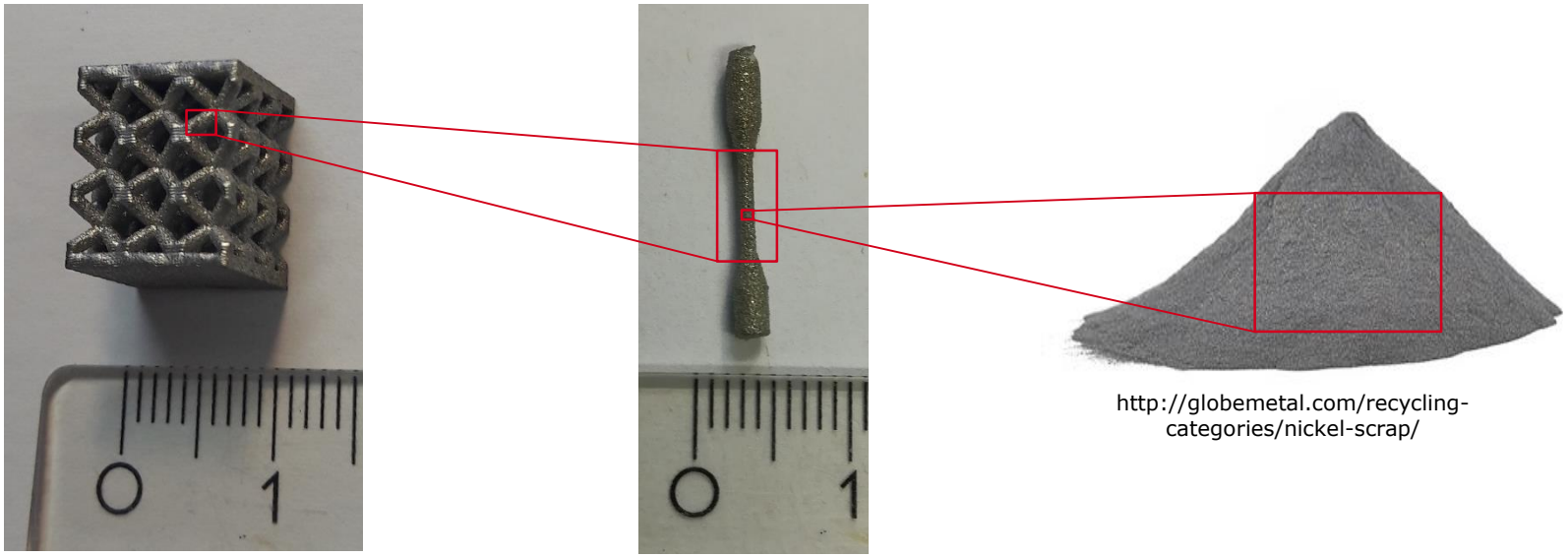


http://www.qualifiedrapidproducts.com



Douglas (1999)

Agenda

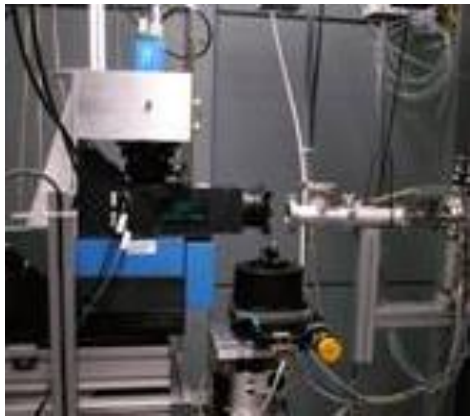


http://globemetal.com/recycling-categories/nickel-scrap/

SLM – IN625

Computed Tomography

BAM-Line CT at BessyII



Monochromatic

PARALLEL BEAM

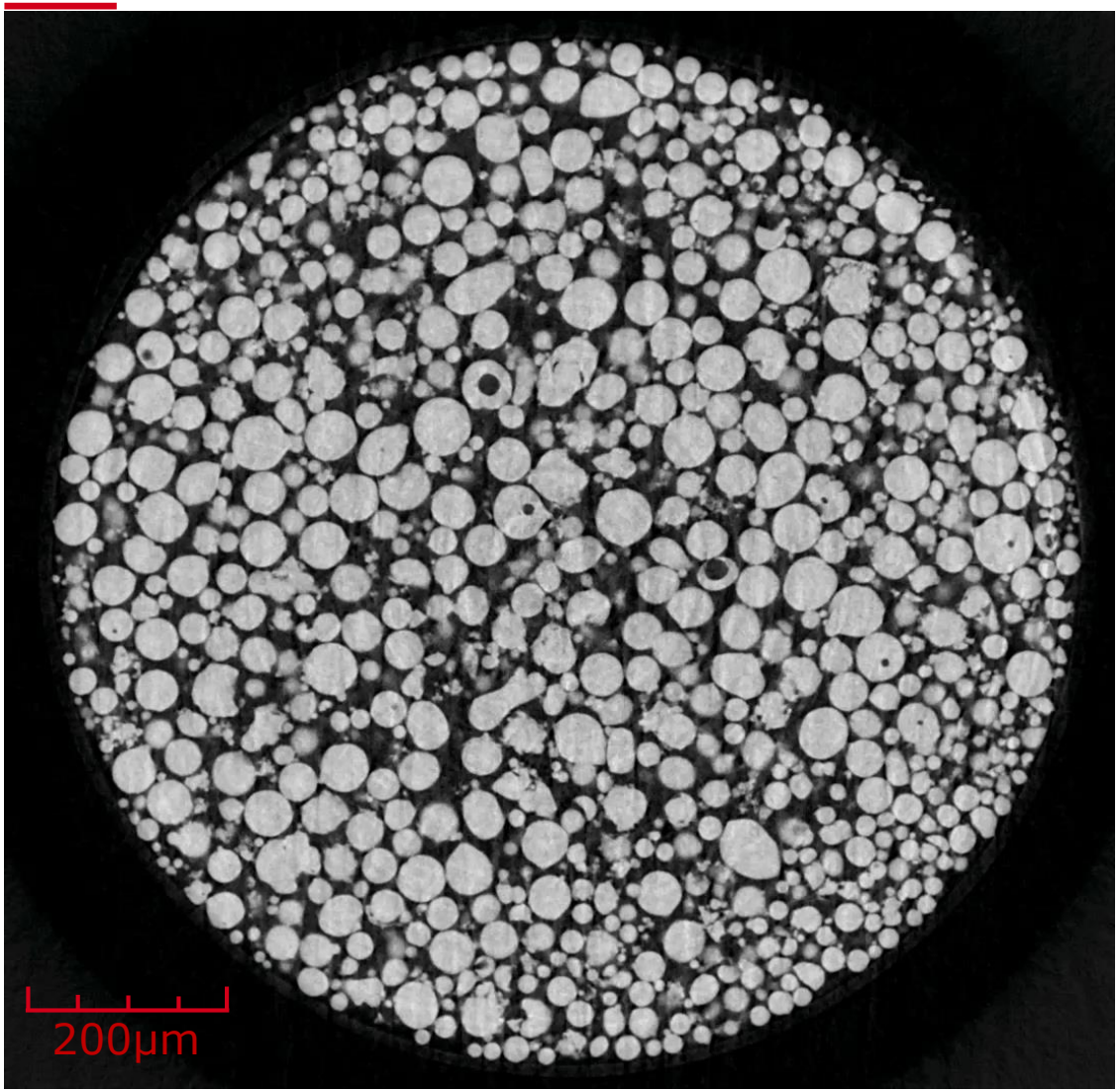
Voxel size: >0.5 µm

Labor µ-CT v|tome|x L 300/180 PA

Polychromatic

CONE BEAM

Voxel size: >2µm

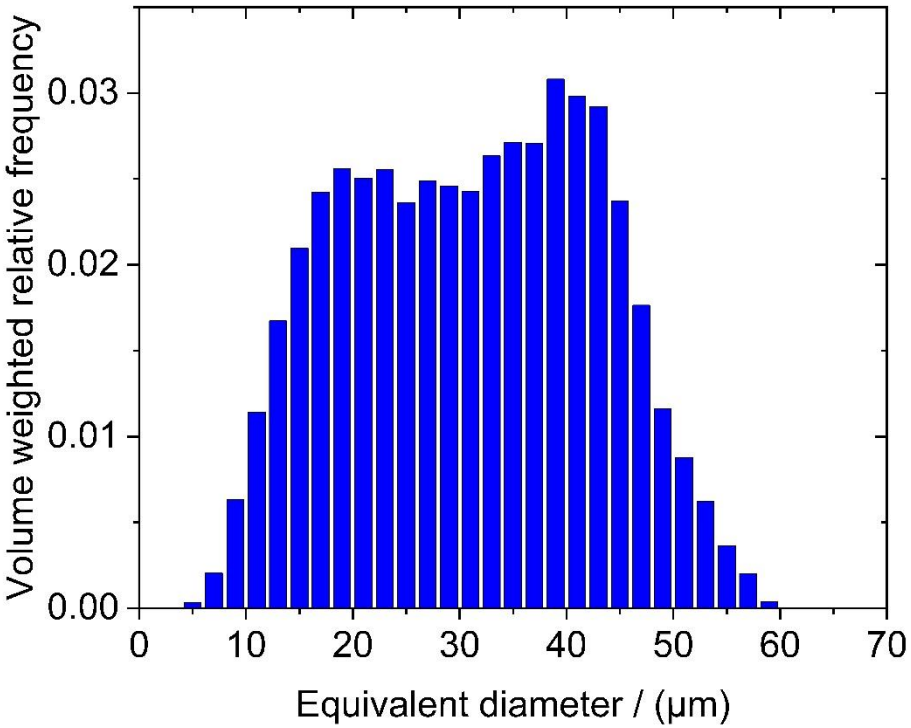


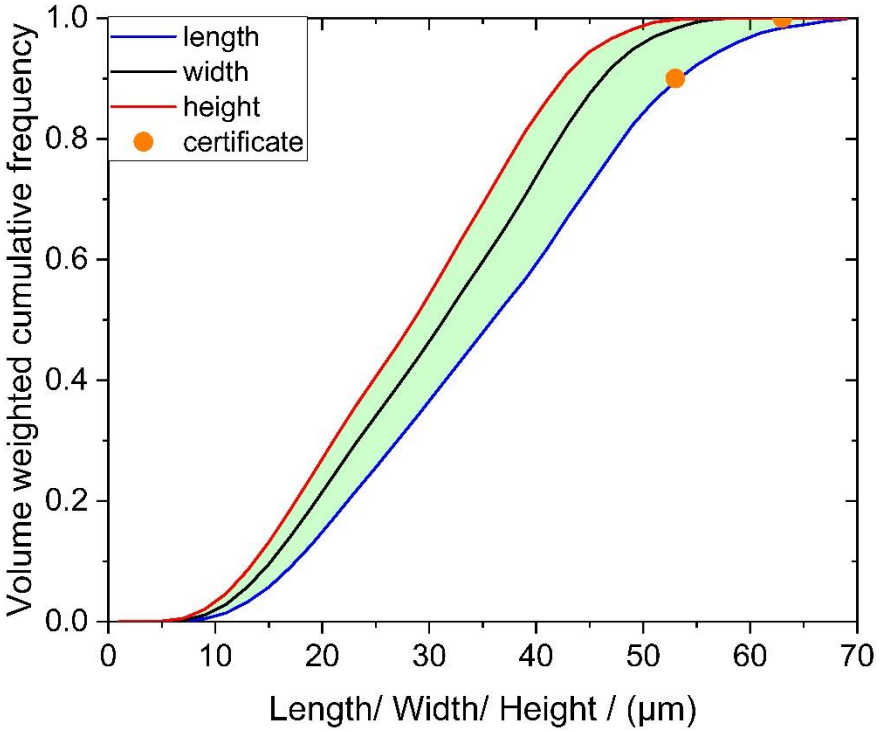
- 1mm diameter
- 0.22 mm height

33000 powder particles

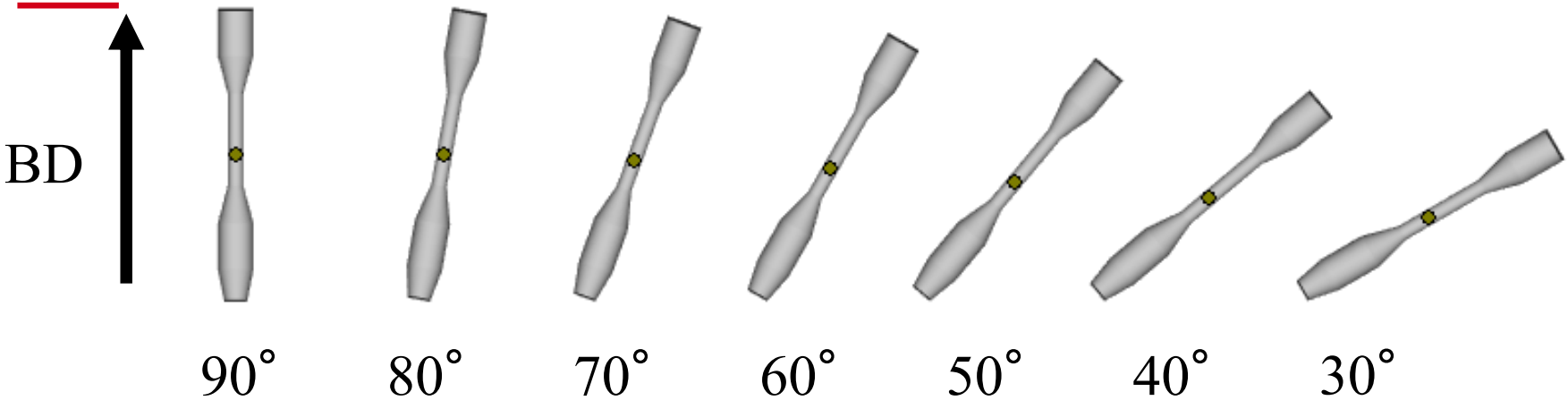
450 pores

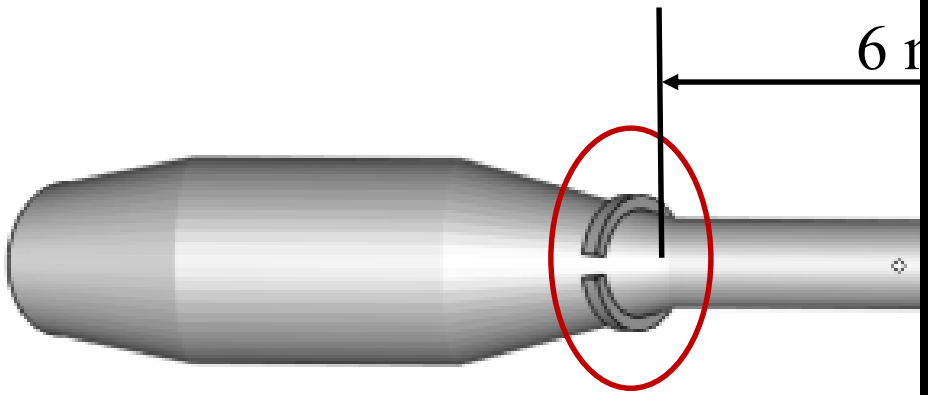
Principal **C**omponent **A**nalysis



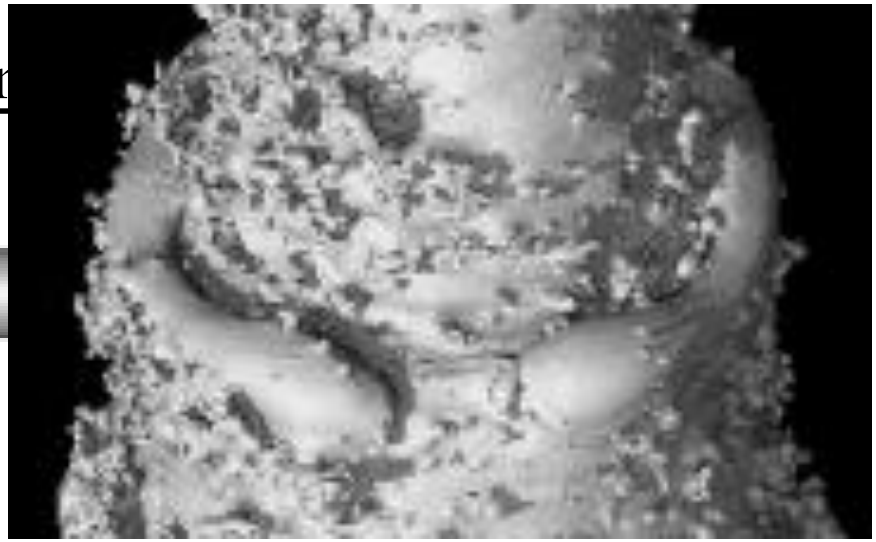


Porosity= 0.05%



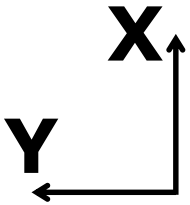


Up-Skin reference



$V_{Pore} \geq 64$ Voxel

1Voxel = 2µm x 2µm x 2µm



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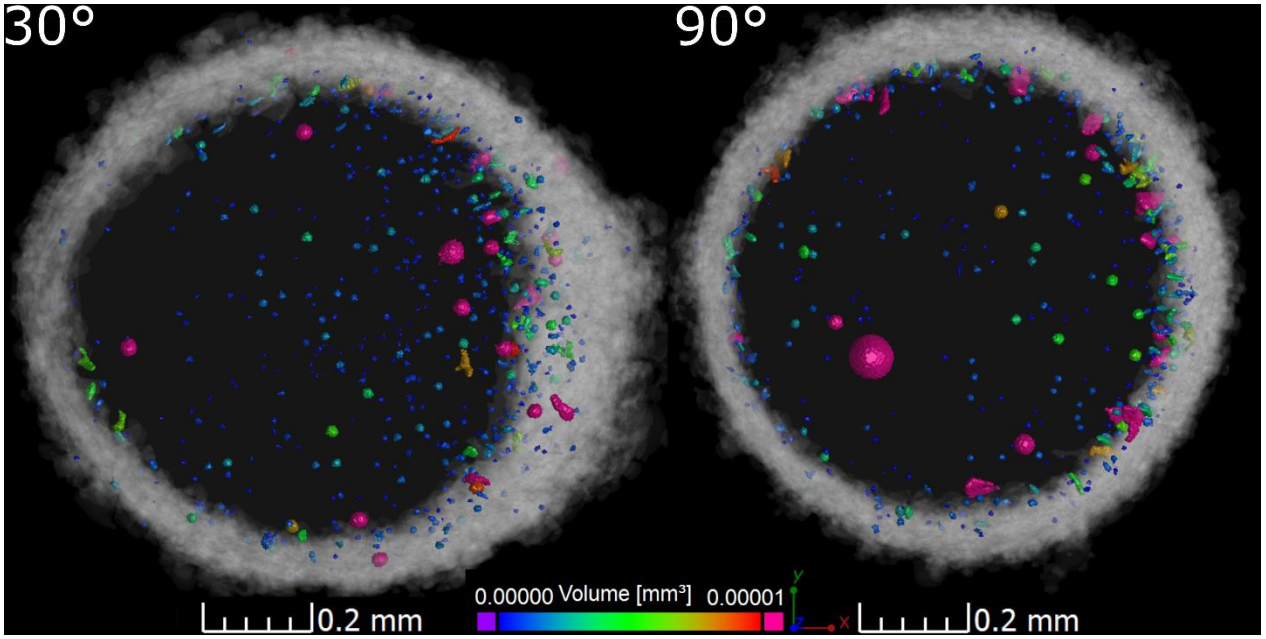
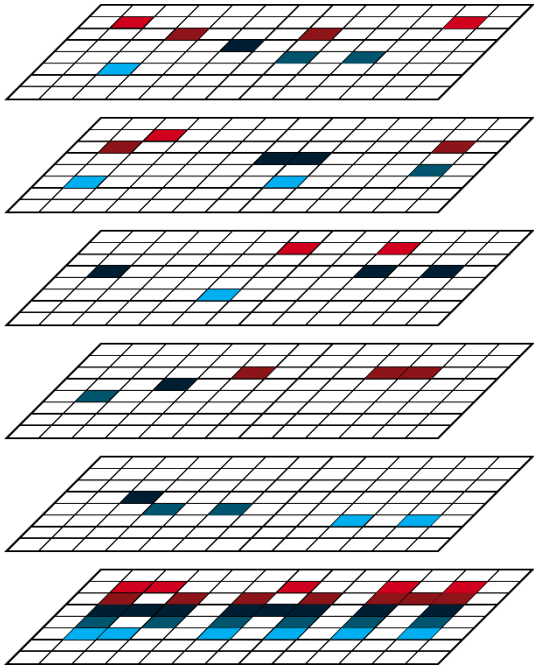
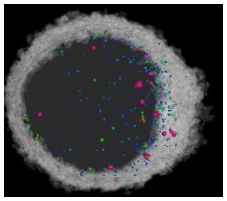


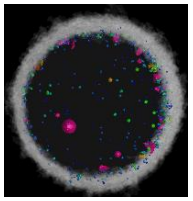


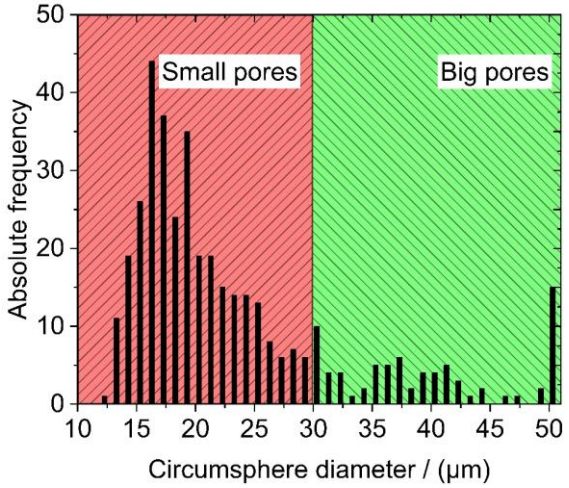
Porosity= 0.02%

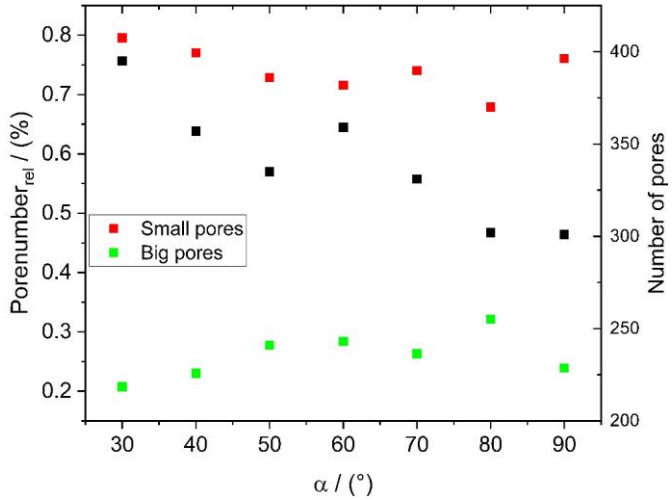
Porosity= 0.03%

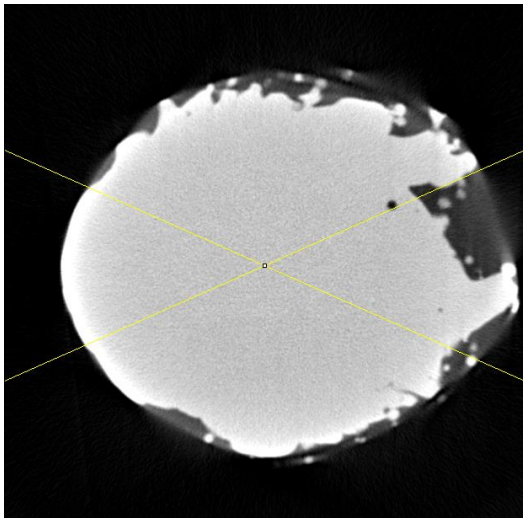
Porosity= 0.05% (powder)

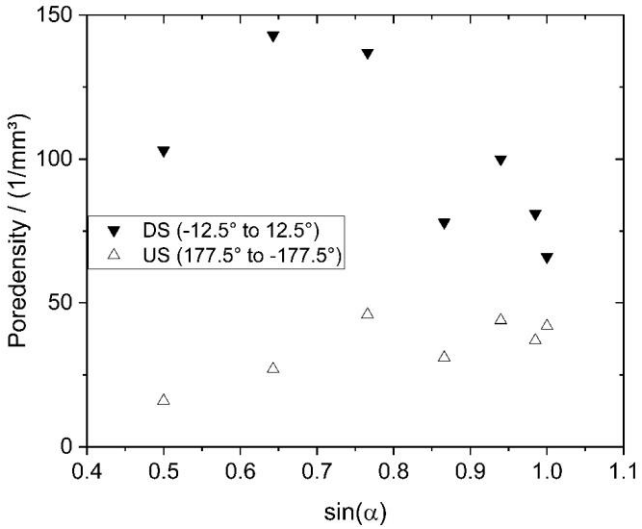


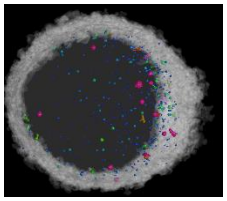


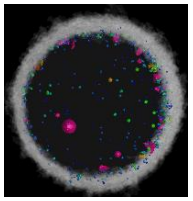

Small pores
Big pores
Absolute frequency
Circumsphere diameter / (µm)


Porenumber$_{rel}$ / (%)
Number of pores
Small pores
Big pores
α / (°)

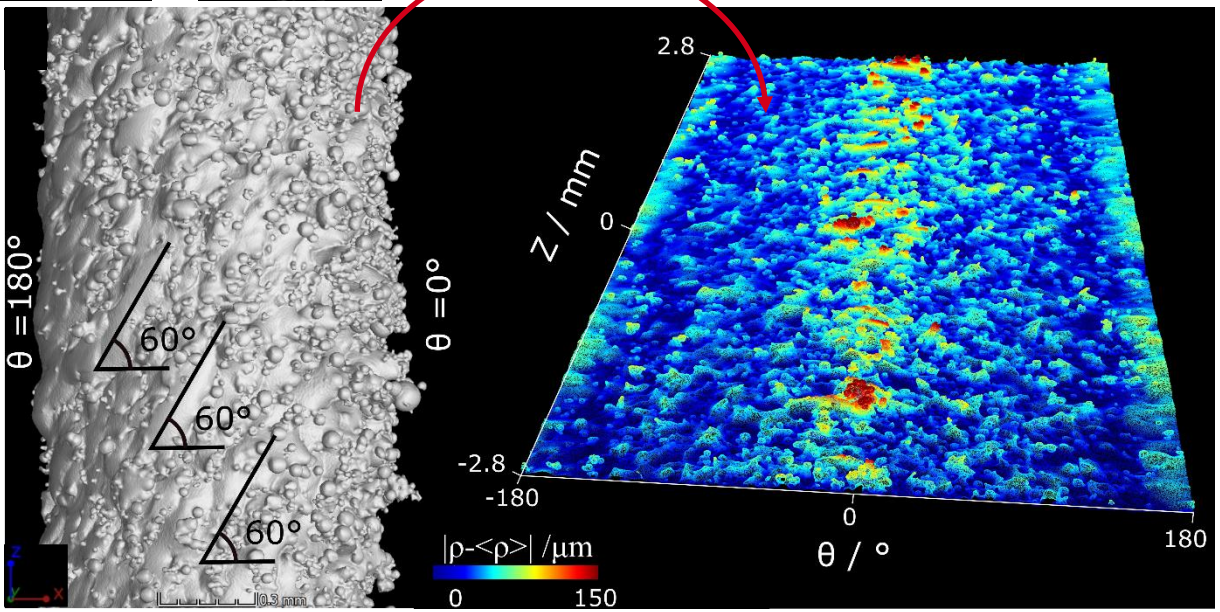


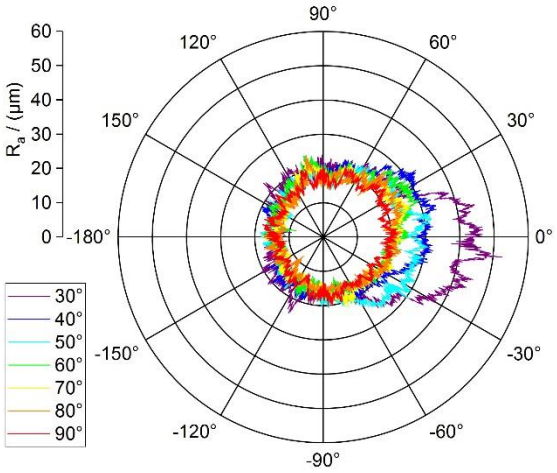

Poredensity / (1/mm³)
DS (-12.5° to 12.5°)
US (177.5° to -177.5°)
sin(α)

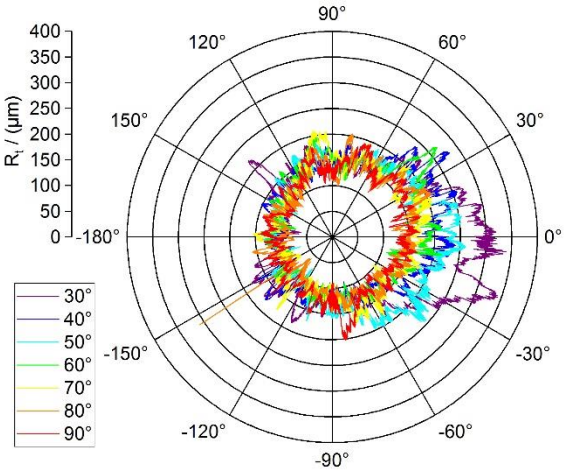


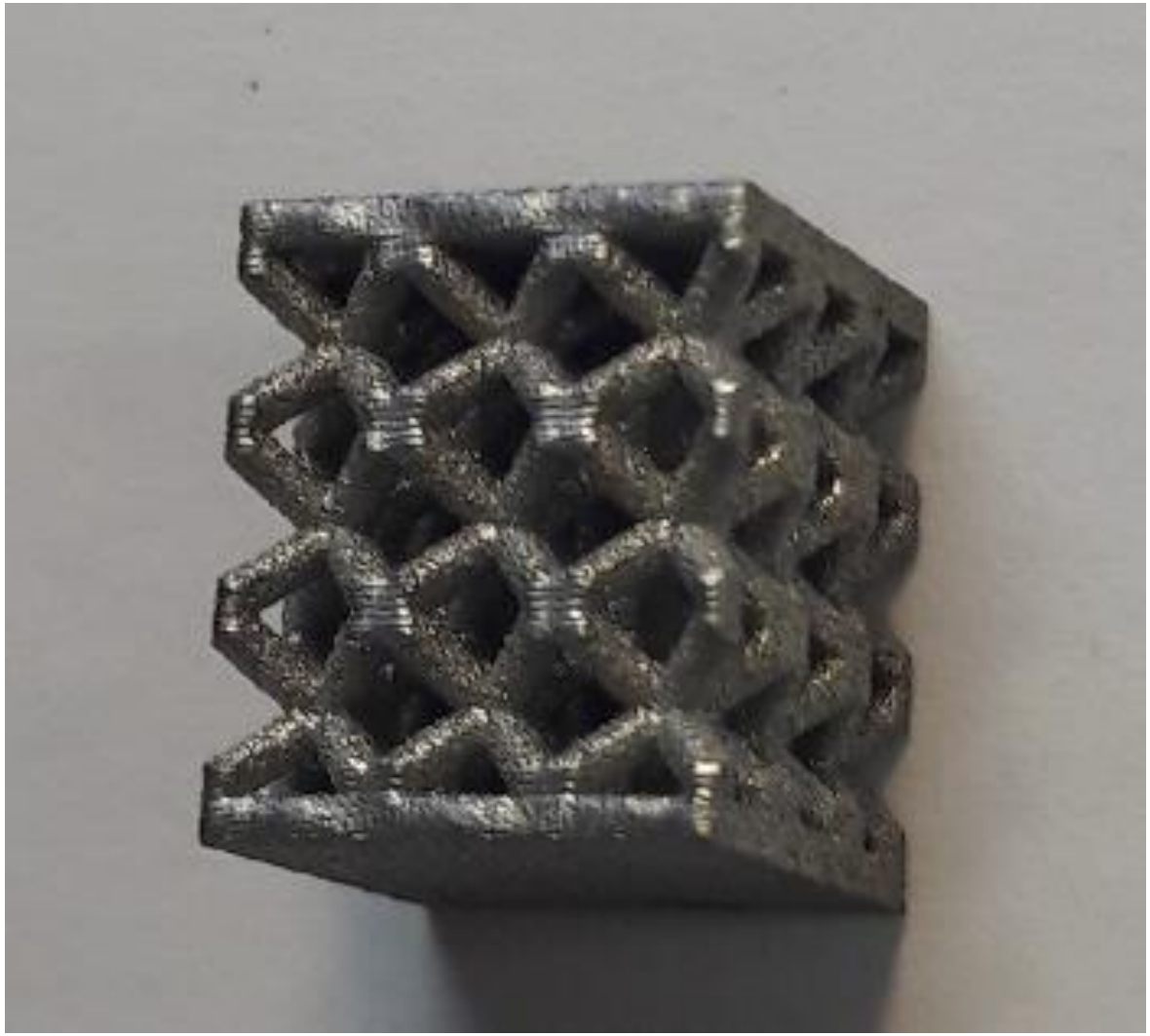


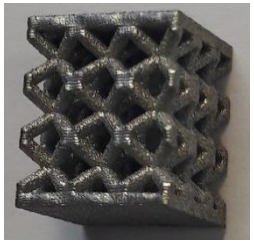
Roll off


θ =180°
θ =0°
60°
60°
60°
2.8
Z / mm
0
-2.8
-180
0
180
θ / °
|ρ-<ρ>| /µm
0
150


R_a / (µm)
30°
40°
50°
60°
70°
80°
90°


R_t / (µm)
30°
40°
50°
60°
70°
80°
90°





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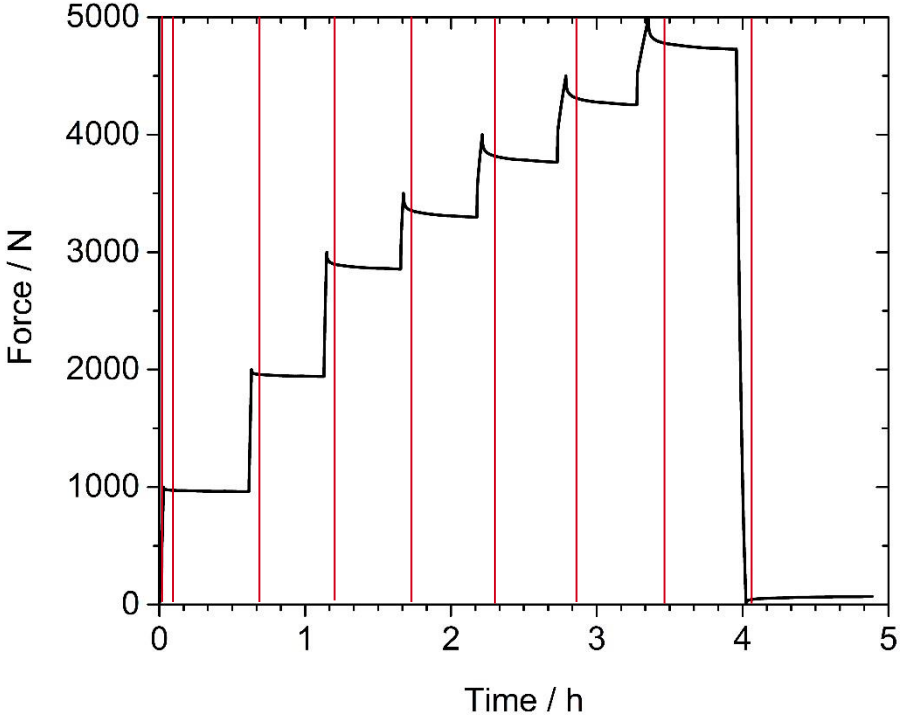
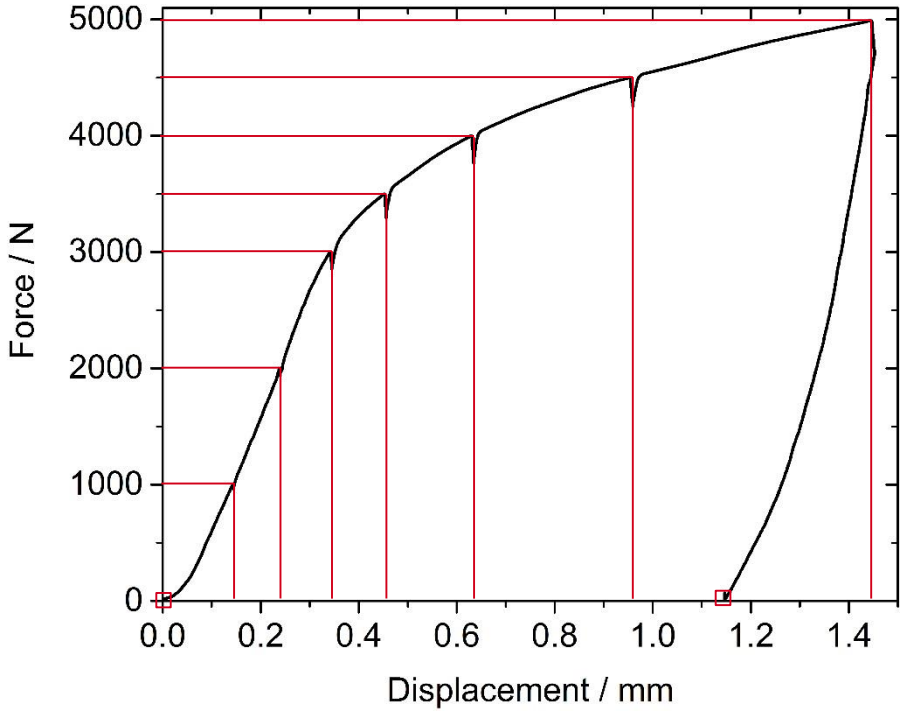
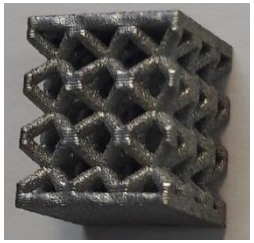
0kN 2kN 3.5kN 4.5kN 0kN'

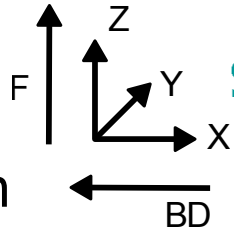
1kN 3kN 4kN 5kN







1Voxel =
20µm x 20µm x 20µm



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0kN

1kN

2kN

3kN

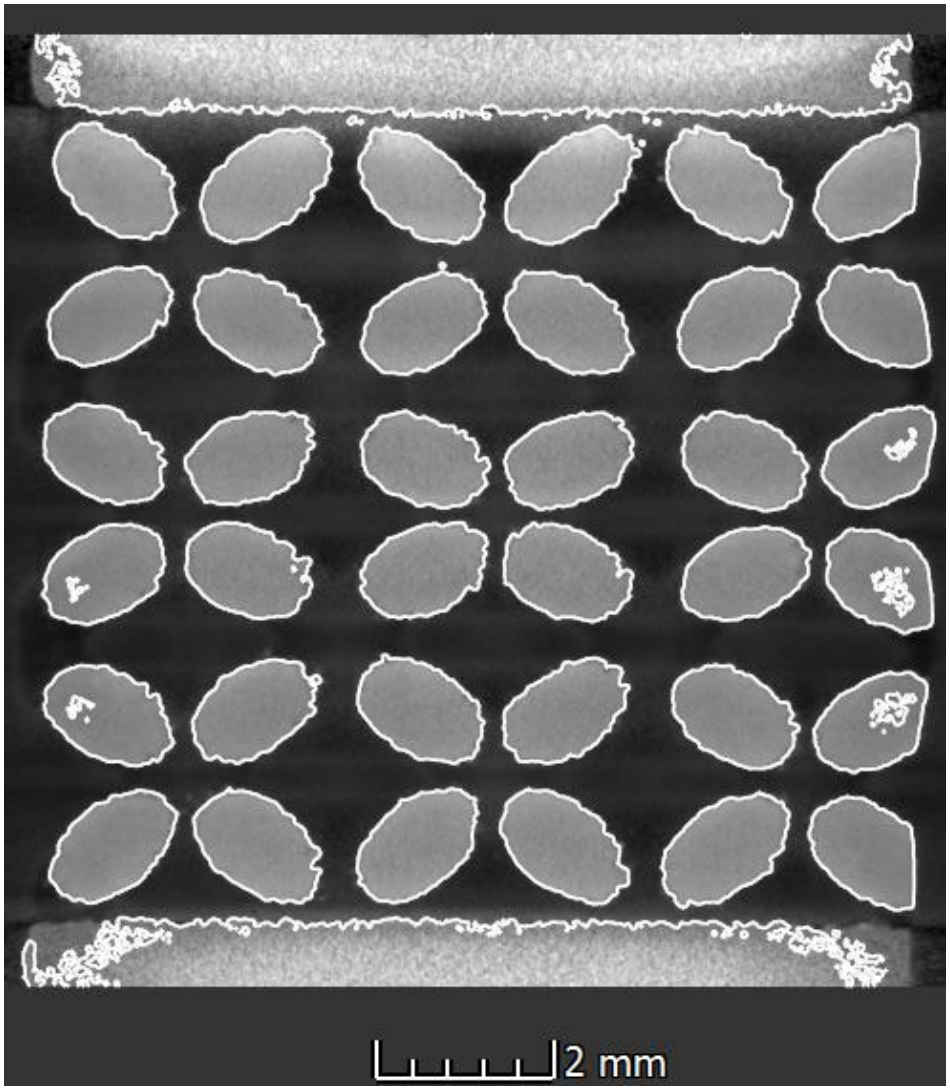
3.5kN

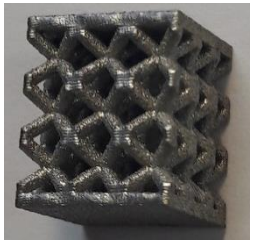
4kN

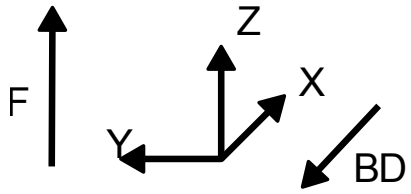
4.5kN

5kN

0kN'







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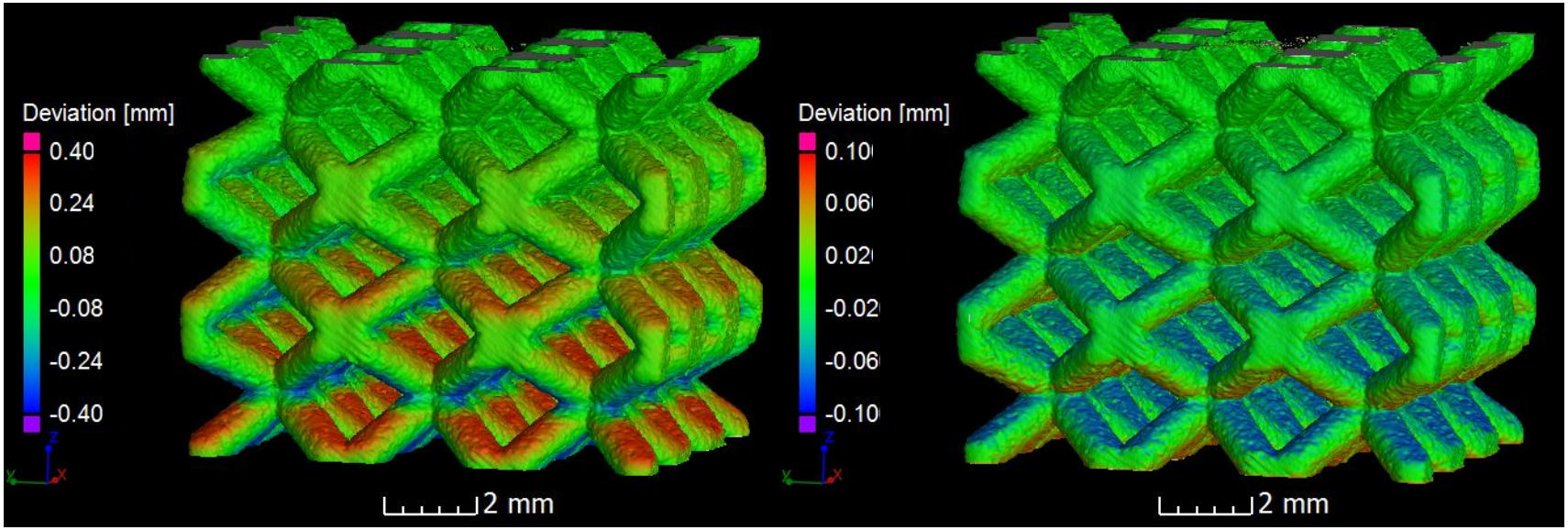
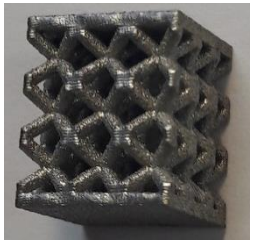
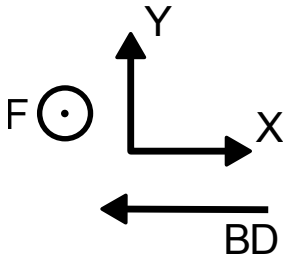
4.5kN to 5kN

5kN to 0kN'







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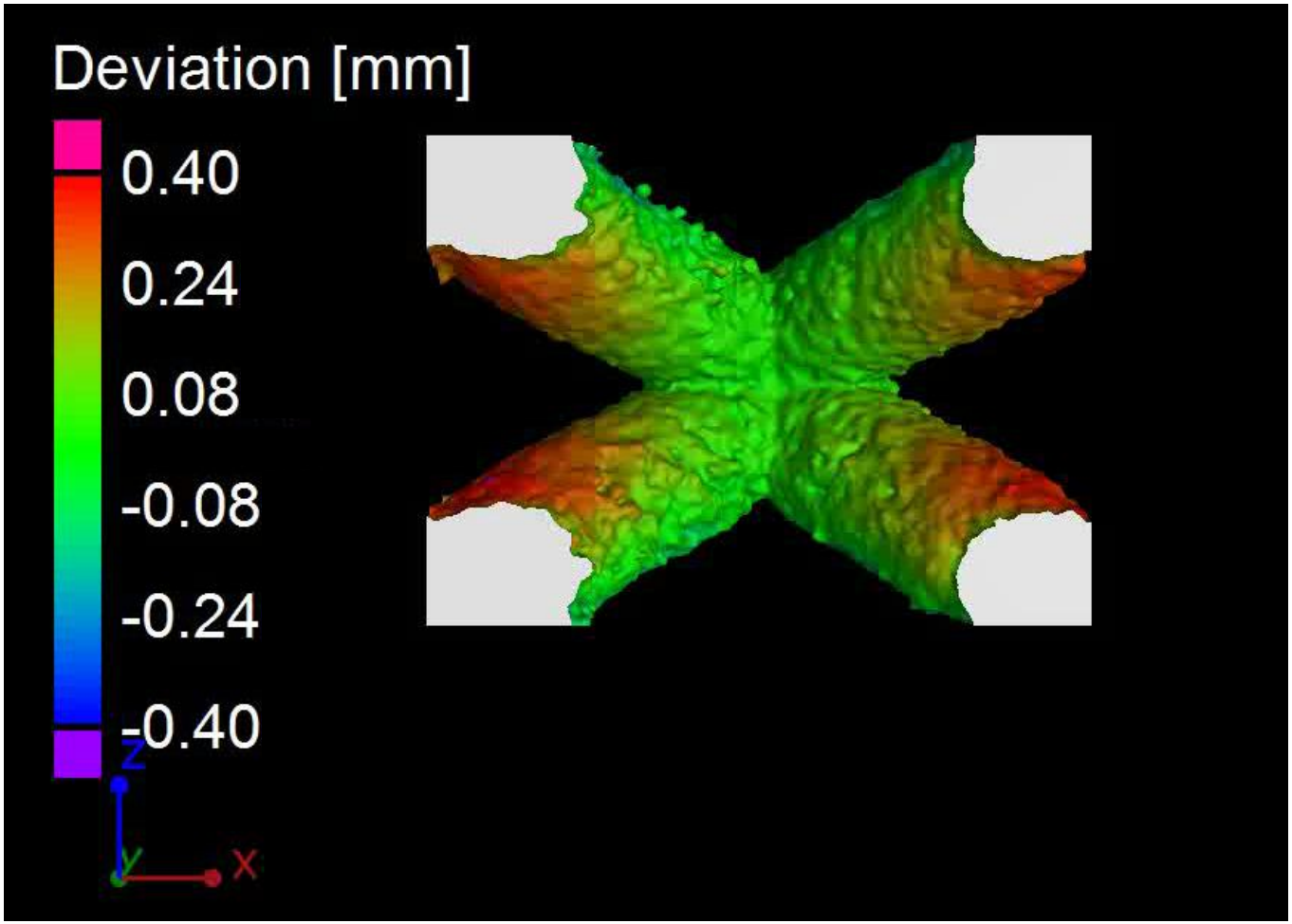

Thank you for your attention!

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tobias.thiede@bam.de

- ✓ Twice the porosity in powder compared to strut
- ✓ Elongated pores only near the edge
- ✓ Staircase-effect explains roughness only partly
- ✓ Lattice structures failed first at the knods