In-situ characterization of tetrahedral microlattices

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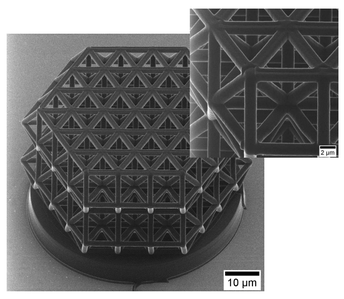
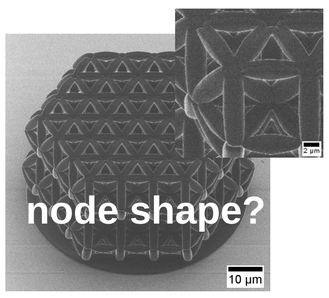
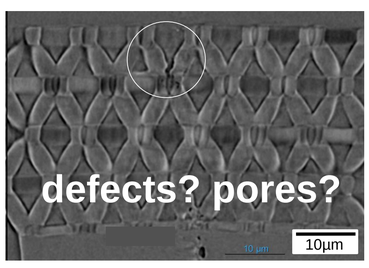
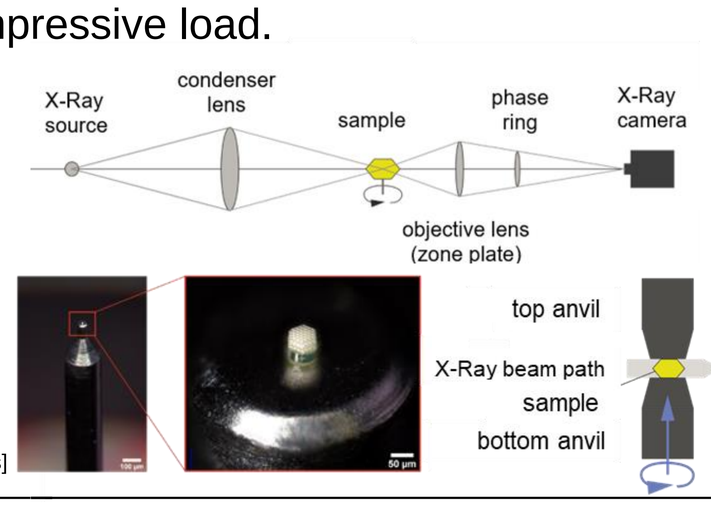
Motivation for the research is a better understanding of the role of node shape and defects in the polymeric base material on the deformation behavior of tetrahedral microlattices under compressive load.

- Manufacturing of polymeric microlattices by 3D direct laser writing
- 3D X-Ray nanotomography (NanoCT) for structural and mechanical analysis





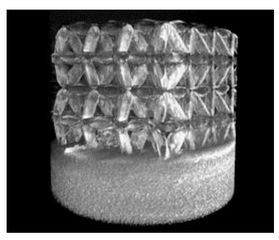




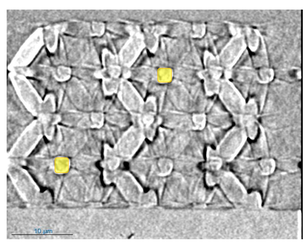
[Zeiss]

Results of NanoCT scans

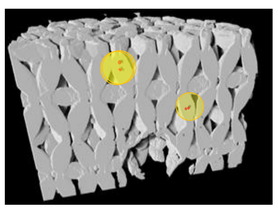
Precise structural analysis of 3D microlattice structures



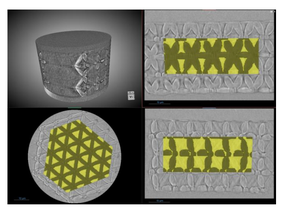
3D model



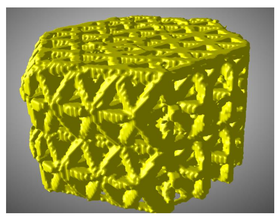
beam shape and dimensions

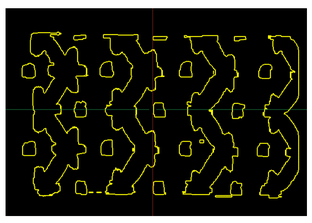


Defect and pore analysis



Relative density



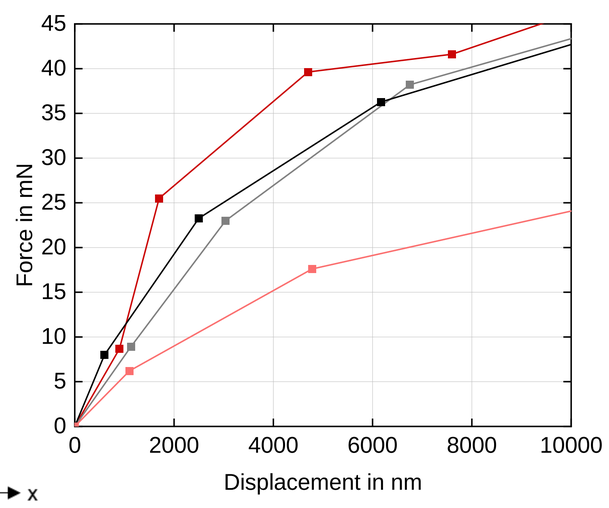


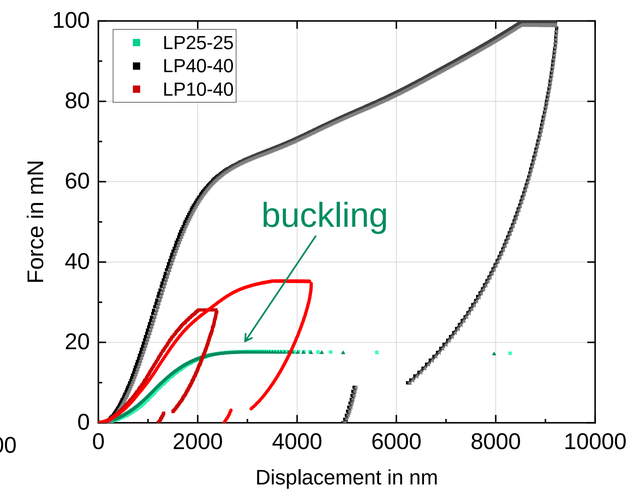
Volume or surface mesh for further processing with FEM software

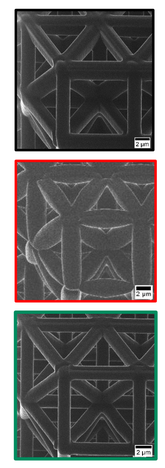
Mechanical results by ex-situ and in-situ compression tests

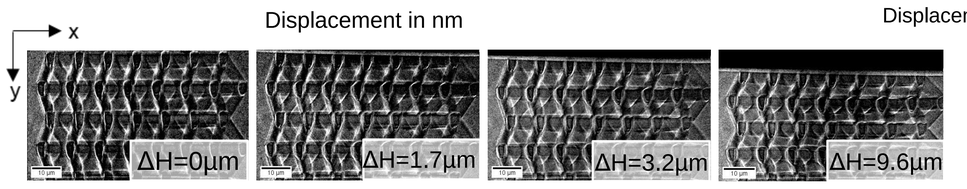
In-situ compression testing with NanoCT load stage

Ex-situ compression testing with Nanoindenter

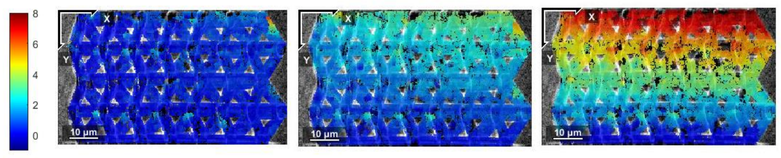




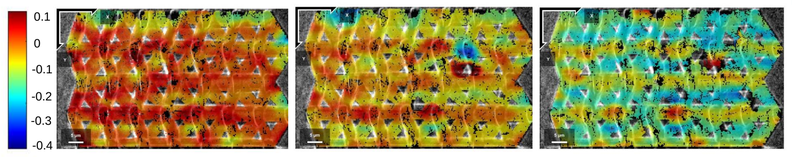




Displacement u_{yy}



Strain ε_{yy}



[Ncorr]

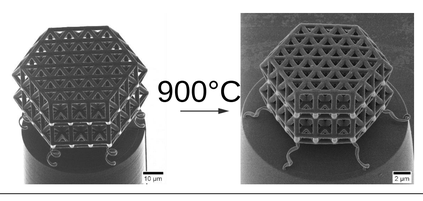
- In-situ and ex-situ compression tests reveal different mechanical properties due to experimental procedure
- Extraction of information by image analysis of NanoCT scans during compression → Digital image correlation (DIC)
- Future work: 3D Digital volume correlation analysis for precise node shape and defect influence on deformation behavior

Take away:

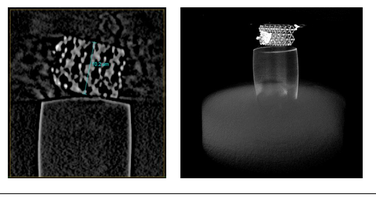
- Precise geometry and defect characterization of polymeric microlattices by 3D X-Ray nanotomography
- In-situ compression tests reveal shape changes and instability localization at internal imperfections
- DIC and DVC analysis to investigate the influence of node shape and internal defects on the global deformation behavior

Outlook:

- Pyrolysis of polymeric lattices to glassy carbon in a vertical furnace and subsequent NanoCT analysis
- 3D Digital Volume Correlation of brittle nanolattices



Nano-CT scans:



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3D MATTER MADE TO ORDER

HEiKA Heidelberg Karlsruhe Strategic Partnership

[Zeiss] after Carl Zeiss X-ray Microscopy, Inc., Hrsg. Xradia Ultra Load Stage User's Guide - Rev B.
[Ncorr] Calculations by Ncorr (Open Source 2D-DIC Matlab Software)