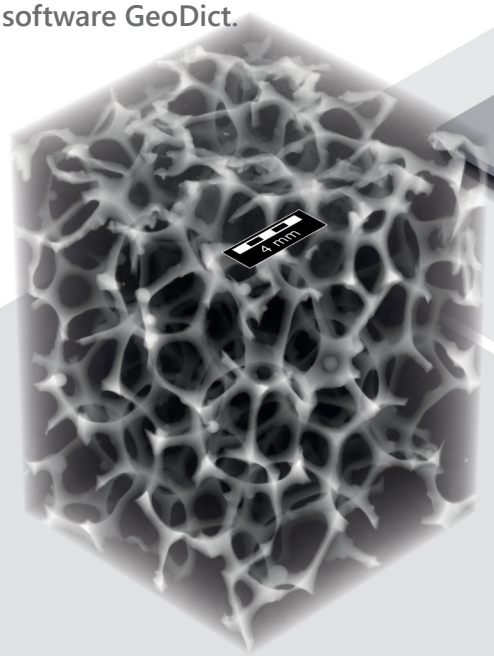
GeoDict

The Digital Material Laboratory

GeoDict Workflow for Simulations on Foams

Compression of an Aluminum Foam: Comparison of experimental in-situ CT scan and simulation

- The deformation of foams under mechanical load is a complex process. The comprehensive characterization of the deformation of a foam is, therefore, not possible using classical compression tests.
- New in-situ computed tomography (CT) technologies widen the scope of these tests. This method offers exciting new insights into the behavior of cellular materials, such as foams.
- We tackled the challenge of performing a compression test on an open-cell aluminum foam during an in-situ CT and afterwards, simulating the process with the simulation software GeoDict.



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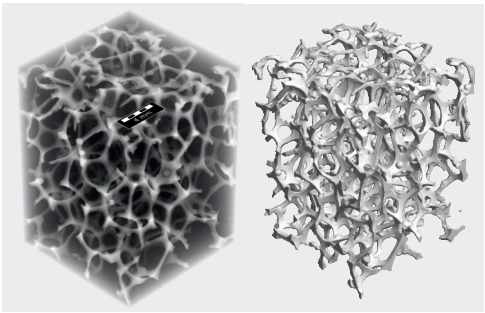
GeoDict® Workflow for Material Development

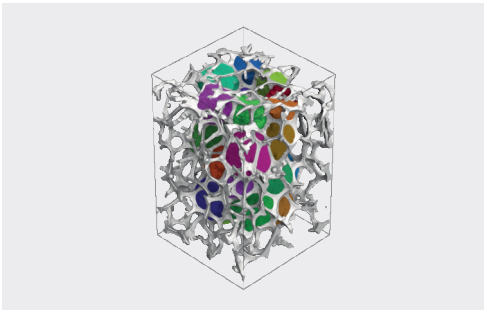
1 Data acquisition



- Import of µCT scans of both foams
- Improvement of the scan's quality through GeoDict image processing tools
- Segmentation of scans into different phases via
  - Automatic OTSU thresholds
- Other available thresholding methods
  - Manual thresholds
  - Multiphase threshold via watershed algorithm
  - AI-based segmentation

Result: Digital twins of the foams

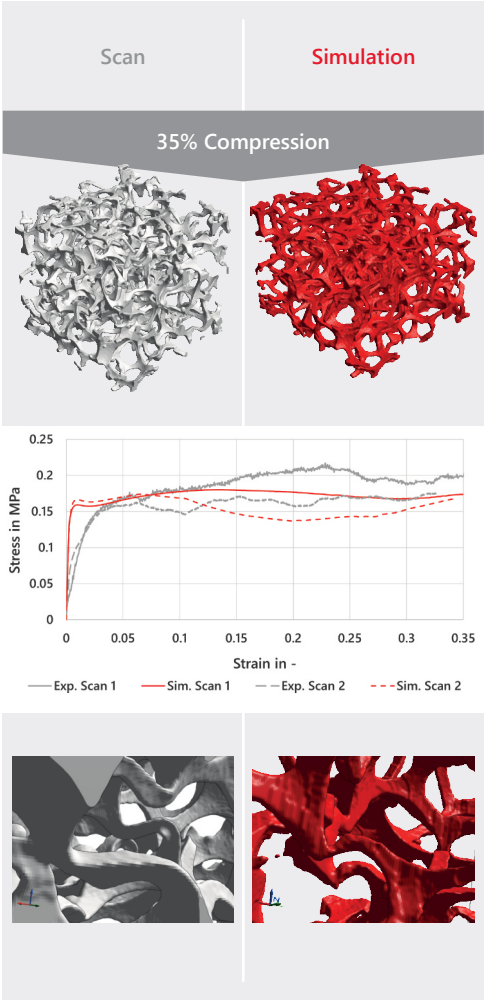
2 Analysis



- Analysis of pore spaces using the PoroDict module
  - Watershed algorithm was used to identify single pores
  - Identification works perfectly, even though the cells of the foam samples are quite open
  - Only pores that do not intersect the domain boundary were analyzed

Result: Statistical description of the foams

3 Simulation of large deformation



- Compression simulations were performed using CT scans of the uncompressed samples.
- Definition of the material law
  - Material of the foam: Al 99.7.
  - Simulation of scan 1 showed that the mechanical properties correspond to heat treatment H112
  - Young's modulus is 70 GPa, the yield strength is 23 MPa, and the elongation at break is 23%.
- Simulation set-up:
  - Compression of 35%
  - Symmetrical boundary conditions in load direction, tangential boundaries were assumed to be stress-free
- Comparison of experiment and simulation
  - Determined that initial stiffness differs between the simulations (in red) and the experiments (in gray).
  - Reason lies in the experimental setup: the foam settles at the beginning of the compression
  - Aside from this difference, the stress-strain curves of the experiment and the simulation agree well.
- Comparison of deformation
  - Buckling of struts is present in both scan and simulation
  - Collapsing of cells is observed in both scan and simulation
  - Simulation shows a good prediction of the deformation

Result: Validated simulation of large compression of foam

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