



An evaluation of 316L tensile tests

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Introduction:

The samples obtained by Sharebot on 21.04.2021 from 1.4404 were examined. The execution was carried out by Robert Kremer (robert.kremer@fh-dortmund.de) at the FH Dortmund.

1. Overview

Five tensile specimen, three lightweight cubes and three density cubes were produced.

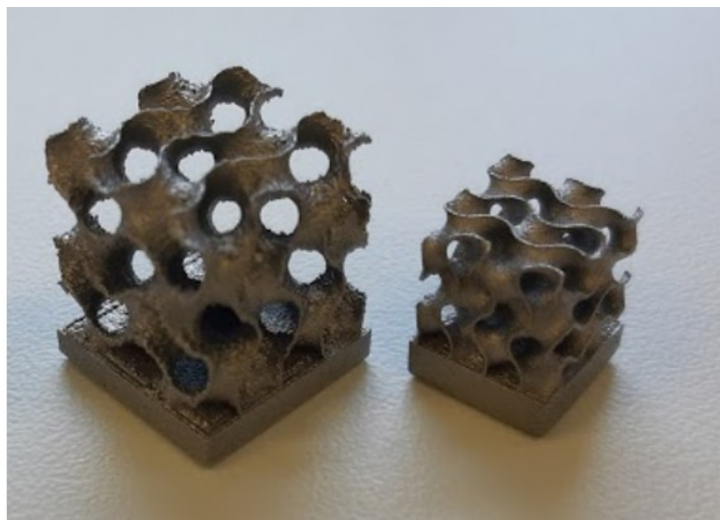
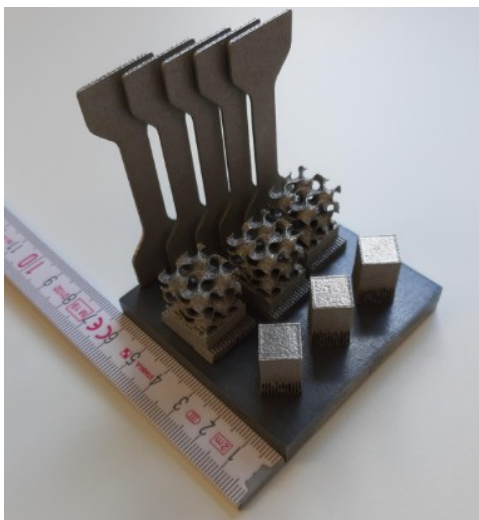


Fig. 2 Samples received on the construction plate **Fig. 2** lightweight cubes in comparison; On the left, the submitted and on the right the own

It is noticeable that the lightweight cubes are larger than required. In addition, the resolution is significantly lower, indicating a larger melting track (more volume energy and/or higher layer thickness) than with the reference sample.

2. Density cube evaluation

Two density cubes were removed from the construction plate and sharpened on all sides. In the following density study by hydrostatic weighing, porosities of 0.7% and 0.2% respectively were determined.

m_Luft	m_Wasser	m_Delta	Volumen	Dichte	Rel. Dichte	Porösität
g	g	g	cm ³	g/cm ³	%	%
7,8688	6,8805	0,9883	0,9900752	7,94767909	99,3	0,7
7,9499	6,9559	0,994	0,99578544	7,98354711	99,8	0,2

Fig. 3 Evaluation of the density study

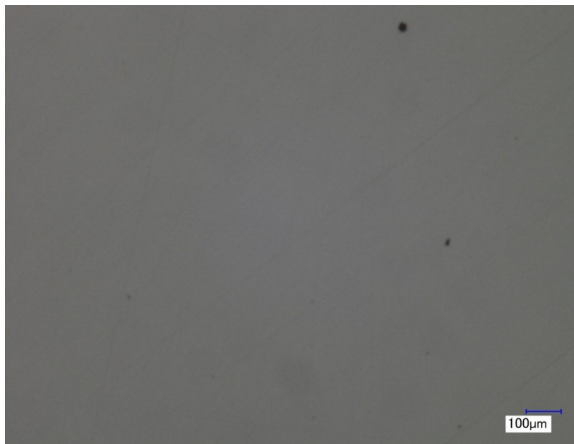


Fig. 4 Polished cross-cut

The two samples were then embedded, sanded, polished and viewed under the microscope. A high density within the component is noticeable.

In the periphery there is an accumulation of pores.

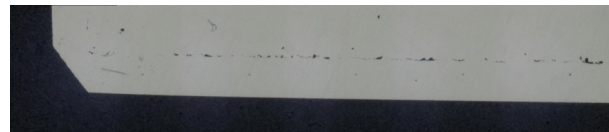


Fig. 5 Close-up of the edge area

After the subsequent etching, it becomes apparent that the edge and surface exposure is not fully connected, which causes the pore accumulation.

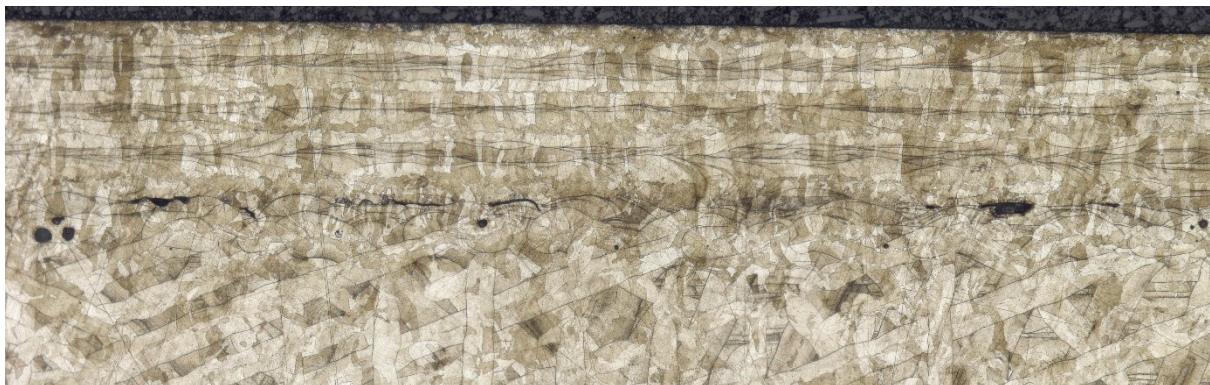


Fig. 6 Etched recording of the edge area with visible errors in the transition area

Overall, the cut images have a typical appearance with visible melting traces.



Fig. 7 Etched plan view with visible melting traces and applied alternating exposure



Fig. 8 Etched Side View

3. Tensile tests analysis

All five tensile samples have a gap in the middle, which is only interrupted by a few bridges. One possible explanation could be the interplay between surface and edge exposure.

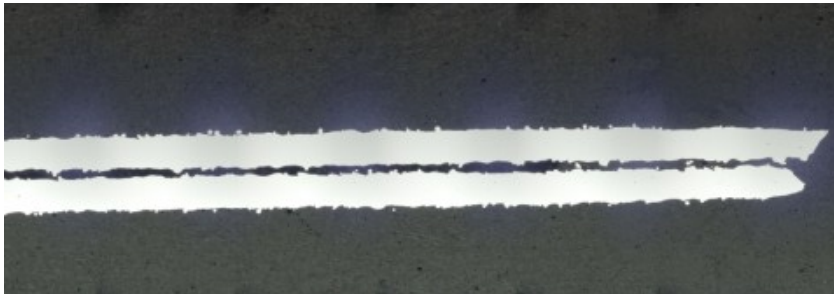


Fig. 9 Ground cross-section of the drawn tensile sample. Clearly recognizable gap within the component

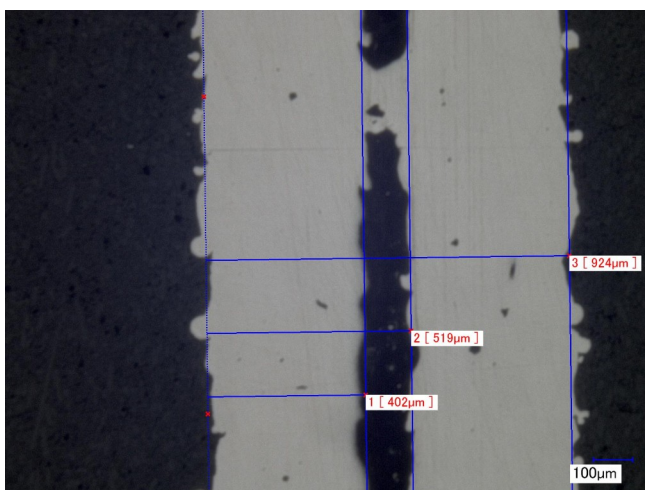


Fig. 10 Measurement of the gap within the tensile sample



Fig. 11 Etched view of the tensile sample

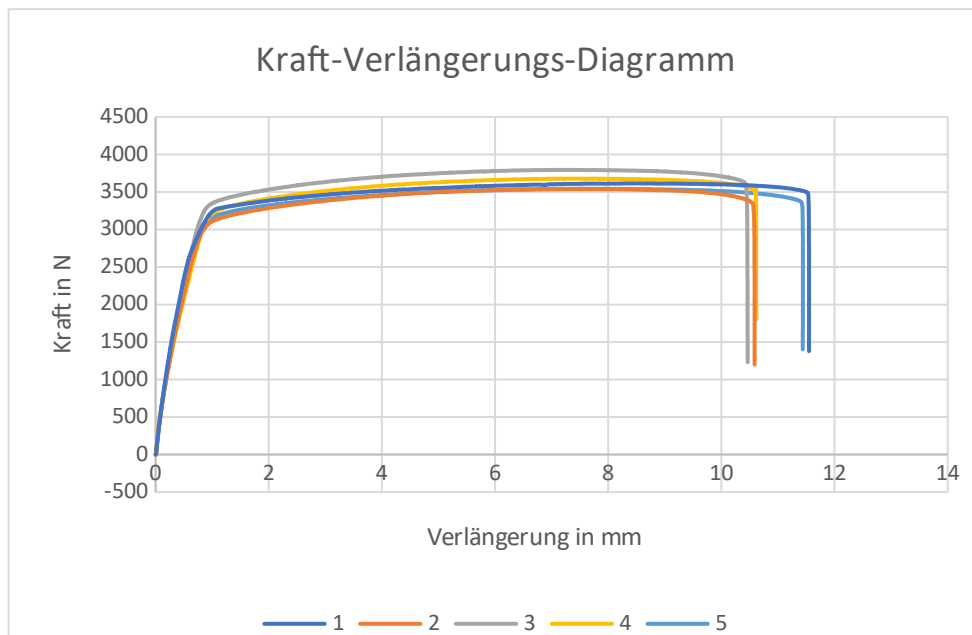
In the etched cut pattern, unmelted powder particles can be seen in the middle.

In the reception of the fracture point, the gap, including adhering particles, can also be seen.



Fig. 12 Plan view of the fracture site

Due to the incompletely constructed tensile samples and the resulting unknown or fluctuating cross-section, only a force-extension diagram is output.



The cross-section estimated on the basis of the microscopic images is 6.4 mm^2 , which corresponds to a tensile strength of approx. 570 MPa (according to literature 500 – 700 MPa). Due to the problem described, however, the value is only partially meaningful.