BAM reference data: Temperature-dependent Young's and shear modulus data for additively and conventionally manufactured variants of austenitic stainless steel AISI 316L

The elastic properties (Young's modulus, shear modulus) of austenitic stainless steel AISI 316L were investigated between room temperature and 900 °C in an additively manufactured variant (laser powder bed fusion, PBF-LB/M) and from a conventional process route (hot rolled sheet). The moduli were determined using the dynamic resonance method. The data set includes information on processing parameters, heat treatments, grain size, specimen dimensions and weight, Young's and shear modulus as well as their measurement uncertainty.

The dataset was generated in an accredited testing lab using calibrated measuring equipment. The calibrations meet the requirements of the test procedure and are metrologically traceable. The dataset was audited as BAM reference data.

Further information on data and data acquisition, analysis, and experimental details are given in the related data descriptor article [1]. Please consider citing it in case the data are used in the context of a scientific publication.

Figures

Some of the temperature dependent Young's and shear modulus data for the alloy 316L are summarized in Figure 1, Figure 2, and Figure 3. Further interesting correlations can be plotted with the data given in this publication. In general, there are no significant differences between flat-wise and edge-wise peaks. Macroscopic quasi-isotropy is evident.

As several process parameters were varied, interesting dependencies can be derived. Exemplified by the Young's modulus:

i) There are significant differences in Young's modulus values between the two layer thicknesses of the vertical towers (0°) (Figure 1). The specimens produced with a layer thickness of 30 µm and the accordingly adjusted processing parameters (green dots) result in approx. 5 % higher Young's modulus than those built with a layer thickness of 50 µm (red squares). The conventional material (blue diamonds) falls in between and closer to the 30 µm layer thickness specimens.

ii) For the towers built in three different orientations with 30 µm layer thickness, the vertical (0°, green dots) and diagonal (45°) orientations (red triangles) show identical values, the horizontal (90°) orientation (yellow squares) shows approx. 6 % higher values (Figure 2).

iii) Significant differences in Young's modulus are evident when specimens are extracted from the walls in different directions with respect to the build direction (Figure 3, layer thickness 50 µm). The horizontal (90°) orientation (red dots) gives about 28 % higher values than the vertical orientation (0°, yellow dots). The diagonal (45°) orientation (green dots) is in between, and the conventional material (blue diamonds) falls between the horizontal and diagonal orientations.

DOI: 10.5281/zenodo.7813835

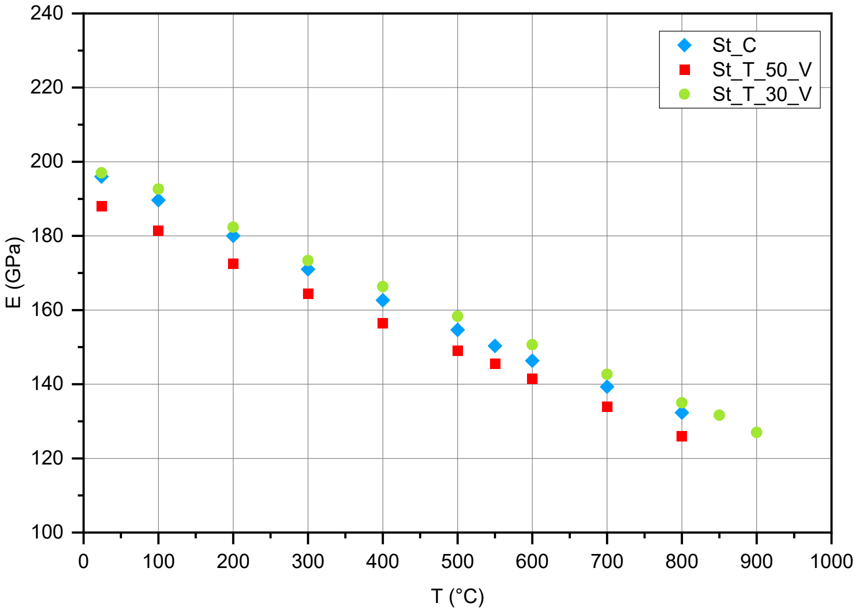

Figure 1. Temperature dependent Young's modulus, E, of alloy AISI316L. PBF-LB/M: additively manufactured material (tower) in build direction (0°) and different powder layer thicknesses 30 µm (St_T_30_V) and 50 µm (St_T_50_V) and conventionally manufactured (St_C). Data points represent mean values of two measurements for layer thickness 50 µm and three measurements for the other two states.

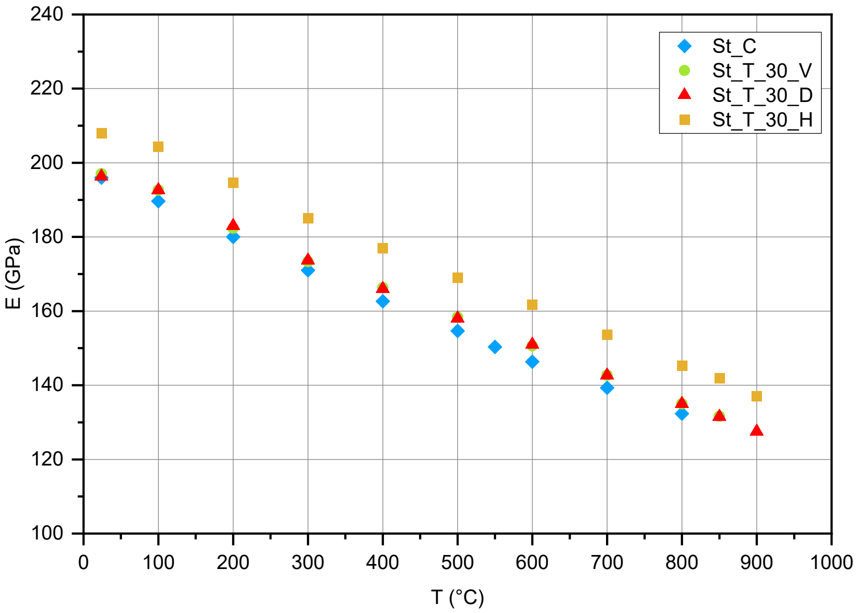

Figure 2. Temperature dependent Young's modulus, E, of PBF-LB/M/316L material (towers, layer thickness 30 µm) in three build directions (0°, 45°, 90° denoted as V, D, H in the legend) and conventionally manufactured (St_C). Data points represent mean values of three measurements each.

DOI: 10.5281/zenodo.7813835

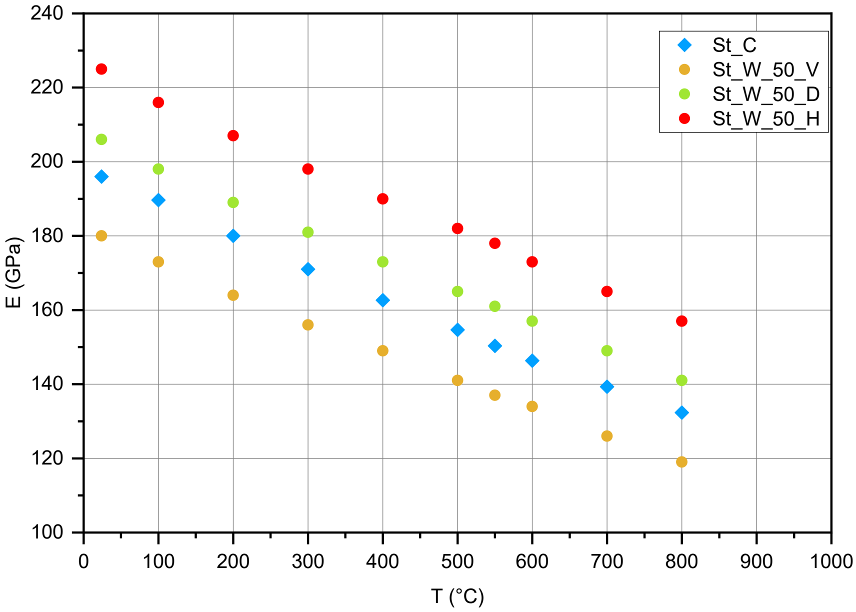

Figure 3. Temperature dependent Young's modulus, E, of PBF-LB/M316L material (walls, layer thickness 50 µm). Different orientations of specimen L-direction relative to building direction (0°, 45°, 90° denoted as V, D, H in the legend) and conventionally manufactured (St_C). Data points represent mean values of two measurements for 0° and one measurement for the other two orientations.

References

[1] B. Rehmer, F. Bayram, L.A. Ávila Calderón, G. Mohr, B. Skrotzki, Elastic modulus data for additively and conventionally manufactured variants of Ti-6Al-4V, IN718 and AISI 316 L, Scientific Data 10(1) (2023) 474. https://doi.org/10.1038/s41597-023-02387-6

DOI: 10.5281/zenodo.7813835