

Reviewer #2

General Comment

The present research deals with the study of the fatigue behaviour of auxetic topology optimized structures of AlSi10Mg alloy made by Selective Laser Melting process. The fatigue performances were evaluated considering the effect of the fillet radius of the auxetic structure by using the strain-life approach.

Comment #1:

Even if the motivation for optimizing the topology of auxetic structures is clear, the explanation of the smoothing procedure quoted at line 125 requires to be improved: the authors can include a bullet list of the steps of the smoothing or a figure representing the algorithm that includes each image reported in figure 2.

Response:

The text regarding the Figure 2 was rewritten as follows:

The smoothing procedure described above, consists of the following 5 steps:

1. Selection of the topology from the Pareto front (Figure 2a, dark grey area).
2. Determination of the medial axis of the topology.
3. Simplification of the medial axis to straight lines between the line connection points (Figure 2b, red lines).
4. Thickening of the simplified medial axis to obtain the geometry; the horizontal and vertical lines retained their thickness, while a new thickness was defined to the oblique lines of the medial axis. The thickness of these lines was set to such a value that the topology area remained the same (Figure 2b, light grey area).
5. All remaining sharp corners were rounded using an equal fillet radius R (Figure 2c).

Comment #2:

It would increase the soundness of the research to include in the text the Pareto front and more in-depth on its application to the present study.

Response:

In this paper, the focus of the research was not the topology optimisation of the auxetic cellular structures. Topology optimisation is described in detail in the paper "Borovinšek, M.; Novak, N.; Vesenjaj, M.; Ren, Z.; Ulbin, M. Designing 2D Auxetic Structures Using Multi-Objective Topology Optimization. *Mater. Sci. Eng. A* **2020**, *in review (second round)*". In this paper, the results (auxetic cell geometries) of the mentioned topology optimisation study are used. To keep the focus of this paper on the fatigue behaviour, the reader is kindly

directed to the article by Borovinšek et al. [65]. Additional reference to the paper was added to the line 118 of the manuscript.

Comment #3:

Please provide more explanations on the choice of the Topologies from Pareto's front.

Response:

The resulting Pareto front [contains 200 different topologies](#) (this information was added to the manuscript: Chapter 2.2, last paragraph). To analyse the fatigue behaviour of the obtained topologies, five topologies were selected from the resulting 200. Some of those 200 topologies are close together on the Pareto front, while some are further apart from each other. To get a good representation of the resulting Pareto front, the five topologies were selected as described in Chapter 2.2, last paragraph. The defined selection process results in topologies, which are almost equally apart from each other on the Pareto front and represent the whole Pareto front as good as possible. The following sentence was added to the manuscript (Chapter 2.2, last paragraph) to provide this information to the reader:

[The resulting five topologies are almost equally apart from each other on the Pareto front; thus, they are a good representation of the best solution set.](#)

Comment #4:

Please improve the quality of Figure 4b.

Response:

The quality of Figure 4b has been improved.

Comment #5:

Table 2: The author said that two samples were addressed to static tensile tests. So, the values presented in Table 2 represent the mean values through two tests. Please provide specifications. In order to have a statistical significant results it would have been better to increase the sample number being tested.

Response:

Authors agree with the reviewer that it would be better to test more samples. However, [the measured quasi-static stress-strain responses were almost the same for both tested specimens and are also in a good agreement with the experimental results from other researchers \[67\]](#). This explanation has been added in Section 3.1 of the revised manuscript.

Comment #6:

The main concern of the present paper is such that the work for to the fatigue life assessments refers mostly to the numerical analysis. In effect, the authors used the equivalent amplitude strains assessed by means of

the numerical analysis to obtain the number of cycles to failure. Please clarify in the text the reason for a purely numerical investigation.

Response:

As mentioned in the Introduction, research work in the presented study is focused on the computational determination of fatigue life of different auxetic cellular structures made of the DMLS AlSi10Mg alloy. As described in Section 2, the analysed cellular structures were previously optimised and then subjected to the fatigue analyses using the appropriate numerical approach. Once the most suitable structure regarding the fatigue strength is determined numerically, the appropriate experimental testing could be performed in the

future to confirm the computational results. A similar statement is also written in the last paragraph of Conclusions. To clarify that the manuscript is based on the numerical analysis, the title was also revised.

Comment #7:

Fatigue life usually is discussed referring to the Strain/N graph. Why in figure 11 the axes are inverted, is there any particular reason for that representation?

Response:

The graph in Figure 11 was inverted and changed to R/N form.

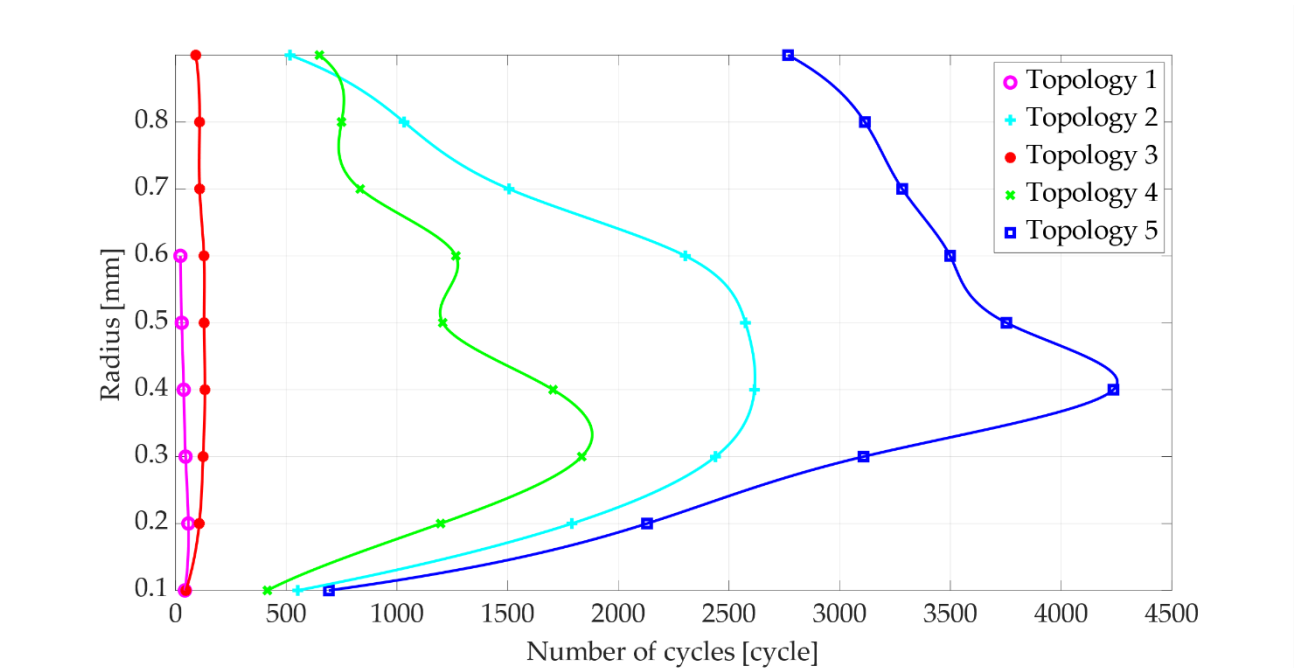


Figure 11. The fatigue life of different topologies and fillet radiuses

Comment #8:

Can the author motivate the choice of the applied load (displacement of 0.4 mm)? Which was the strain ratio applied? Did the author consider the effect of strain-ratio (minimum strain vs maximum strain) on the fatigue behaviour?

Response:

Two statements were added to clarify the selection of the 0.4 mm displacement (see Section 3.2):

Such loading was chosen to induce plasticity in all structures. The higher loading displacement would cause severe plasticity in some structures. Similarly, a lower value of the displacement would not cause plastic strain in some structures.

Strain ratio was not applied and effect of strain-ratio was not considered.