Response to the Editor

22 January 2020

Dear Dr. Mason Ma

Thank you for considering our manuscript (Materials-706328). The reviewers’ comments have been very helpful for improving the quality of our paper and thus have been highly appreciated.

Changes have been made to the manuscript according to the reviewers’ comments. The comments have been addressed and presented below.

Yours sincerely,

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Response to the reviewers

Reviewer #1: The paper focuses on the relevant issue that is investigation of post heat treatment effect on microstructure and mechanical properties of additive manufactured porous titanium alloy.

The presented results are of scientific and practical value. However, there are a number of comments to the paper. Please consider as given below:

Add the measurement error to Table 2. Increase the quality of Figure 5.

Response: Firstly, the authors would like to thank reviewer #1 for the valuable comments on the manuscript. The measurement error on Table 2 has been added, and Figure 5 has been replaced with a higher resolution picture in the revised manuscript.

2. Add comments to Figures 5 a-d. It is necessary to add explanations (with references to the literature) on the change in the microstructure during heat treatment, on the influence of heat treatment and porosity on the mechanical properties of Ti64.

Response: The following statements have been added to the revised manuscript and highlighted in blue in page 5.

“Figure 5 shows the microstructure of the porous Ti64 samples before and after heat treatment. The microstructure of the as-built sample is mainly composed of acicular α′ martensite, because of the extremely high cooling rate during laser melting process, making β domain phase transforms to fine α′ martensite [27]. Some pores were found in the as-built sample, as shown in Figure 5 (a) and (b). This defect may be caused by the heat wave airflow that cannot escape during the solidification, and this defect may have an unfavorable effect on the mechanical properties of the as-built samples [21]. When the samples heat-treated at 750°C and 850°C, it is clear that the fine α′ martensite has been beginning transform to α+β lamellar mixture microstructure and α phases are beginning to present as lath pattern, but there is still some needle-like α phase in their microstructures, as illustrated in Figure 5 (c) to (f). And comparing Figure 5 (d) to Figure (f), the microstructure is more uniform and the α lath is coarser for the samples heat-treated at 850°C. In the case of the specimens heat-treated at 950°C, the fine α′ martensite has completely transformed to a mixture of α+β and α phase shows more obvious lath pattern, as shown in Figure 5 (g) and (h). In short, with the increase of the heat treatment temperature, the average width of the lamellar α phase gradually increased, as illustrated in Figure 6. When heat treatment temperature increased to 950°C, the average width of α lath increased to 3.1 μm, as shown in Figure 6.

Figure 7 shows the XRD pattern of the as-built and heat-treated samples.
According to previous research [22], it is difficult to distinguish between α and α’ phases, because those two phases have the similar hexagonal (hcp) structure, therefore all peaks of as-built sample can also be considered as α or α’ phase. The XRD peak intensity of β phase is relatively low for the samples heat-treated at 750°C and 850°C, it’s even hard to see the presence of the β-peak. This indicates that these samples contain very low transformed β phase. And the β phase peak intensity is higher for the samples heat-treated at 950°C. The content of β phase in this heat treatment condition is still low, according to previous research [17]. ”