Microscale surface structure analysis of additively manufactured Ti alloy parts

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Abstract

Quality assessment of a manufactured part is critical to ensure its functionality, especially for high-value parts in aerospace, automotive and health industries. Additive manufacturing (AM) is capable of fabricating parts with almost no geometry constraints due to the layer-by-layer processing nature. However, it is difficult to determine the quality of the AM process due to the number of manufacturing parameters and the complexity of the process. In the last decade, there have been numerous studies in the literature to assess the manufacturing quality of AM using process measurement or monitoring methods [1]. The built surface of the manufactured part carries information about the quality of the fabrication, and the structures formed on the surface during the fabrication process often affect the quality of the parts. In this work, microscale surface structures manufactured by laser-based powder bed fusion (PBF-LB), which is a popular additive manufacturing method, have been investigated. The specimens analysed were fabricated from titanium alloys using a Renishaw 500Q PBF-LB machine with different process parameters and the analysis was carried out using a scanning electron microscope (SEM, FEI XL30). As a result, as far as we are aware some microscale surface structures (e.g., Figure 1) are reported for the first time, and some possible formation mechanisms for these structures are discussed. We believe these microstructures may be used to assess the quality of the fabrication process. Future work will be to perform chemical analyses to investigate if there is any contamination or oxide formation on the microstructures, and compare the surface of the samples manufactured with other materials.

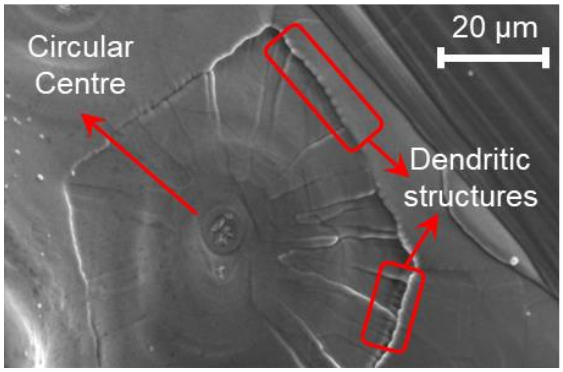

Figure 1: A surface structure shaped like a pentagon with a circular centre and dendritic structures at the edges

Reference

[1] Everton SK, Hirsch M, Stavroulakis PI, Leach RK, Clare AT Review of in-situ process monitoring and in-situ metrology for metal additive manufacturing *Materials and Design* 2016 **95** 431–45