Analysis of post-processing influence on the geometrical and dimensional accuracy of selective laser melting parts

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Abstract

Purpose – This study aims to analyze the effect of the different common post-processes on the geometrical and dimensional accuracy of selective laser melting (SLM) parts.

Design/methodology/approach – An artefact has been designed including cubic features formed by planar surfaces orientated according to the machine axes, covering all the X-Y area of the working space. The artefact has been analyzed both geometrically (flatness, parallelism) and dimensionally (sizes, distances) from coordinate measuring machine measurement results at three stages, namely, as-built, after sand-blasting and after stress-relieving heat treatment.

Findings – Results from the SLM machine used in this study lead to smaller parts than the nominal ones. This effect depends on the direction of the evaluated dimension of the parts, i.e. X, Y or Z direction and is differently affected by the sandblasting post-process (average erosion ratio of 68, 54 and 9 μm, respectively), being practically unaltered by the HT applied after.

Originality/value – This paper shows the influence, from a geometric and dimensional point of view, of two of the most common post-processes used after producing SLM parts, such as sand-blasting and stress-relieving heat treatment, that have not been considered in previous research.

Keywords Accuracy, Selective laser melting, Additive manufacturing, 17-4PH stainless steel, Sandblasting, Stress relieving heat treatment

Paper type Research paper

1. Introduction

Selective laser melting (SLM) is an additive manufacturing (AM) technique that permits to produce high-complex fully functional metallic parts. To achieve this, this AM technique results of great interest for several leading sectors such as aerospace, automotive or medical, in which the dimensional accuracy of the manufactured parts stands out as an important issue.

SLM process belongs to the group classified as powder bed fusion (PBF) techniques, in which a high-density laser selectively melts a thin powder layer distributed upon a built-up plate or upon a previous manufactured layer. During this manufacturing process, the built portion of the part is subjected to a complex thermal cycle, which produces residual stresses on the SLM manufactured part, affecting negatively its dimensional accuracy (Matsumoto *et al.*, 2002) as is well known. These deformations can be related to the characters not only AM built-up process itself but also to SLM laser scanning process parameters (Cheng *et al.*, 2016). According to Bartlett and Li (2019) stated in their analysis of the current state of knowledge, the main parameters of the SLM process that have a major influence upon residual stresses, regardless of the material, are built-up plate heating, laser power, scanning speed and scanning strategy. Apart from other sources of dimensional errors, such as laser spot positioning errors over the powder bed, the deformation induced in the parts by the thermal stresses cited above is still an important issue nowadays. Moreover, all the post-process procedures that can relieve or alter them, i.e. heat treatment (HT) post-processes, have to be considered.

Due to the characteristics of the SLM technique and the as-built condition of the parts, several post-processing operations are required. Some of them are mandatory while others permit to improve the quality of the parts, i.e. mechanical properties, dimensional accuracy, surface quality, etc. These post-processing procedures can be classified as mechanical and HT procedures.

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