Effect of Selective Laser Melting (SLM) anisotropies of Ti-6Al-4V parts on Micromilling process

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Abstract

The 3D printing process through Selective Laser Melting (SLM) has gained attention in manufacturing near net shape components, due to less material consumption and its innovation potential in terms of capability of generating complex geometries. SLM parts, due to its sintering strategies, present two specific characteristics: a periodic waviness surface related with the thickness of the fusion powder layer, and anisotropies regarding the sintering direction. Some parts are required to have reference surfaces, dimensional and geometric tolerances, and/or specific roughness that are obtained by the machining process. However, the effect of waviness and anisotropy on the machinability, specifically on the micromachining process, are barely known.

The aim of this study is to analyse the effect of waviness and anisotropy over micromilling process outcomes for Ti6Al4V samples printed by SLM. To do that, Ti6Al4V samples were printed sizing $50 \times 50 \times 20$ mm in two different sintering directions: 0° and 90° degrees. The layer thickness was set at 0.3 µm and the process was done using miniaturized carbide mills with diameters of 0.8 and 0.5 mm, under different cutting conditions. The final surface roughness, tool wear and cutting forces were analysed to see the relation between them and printing direction. Experiments were also conducted on a conventional Ti6Al4V sample, that was used as a reference.

The results shown that the increase in cutting speed has provided an increase in cutting forces and tool wear and a reduction in surface roughness, for both printing directions. Furthermore, shear force, tool wear and surface roughness were relatively higher in the 0° printing direction. Hence, the effect of anisotropy on the machinability of these parts can be highlighted, which could be used to increase efficiency and to reduce manufacturing costs.