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Effect of powder reuse, printing orientation and heat treatment on the microstructure and mechanical properties of Ti-6Al-4V parts produced by laser powder bed fusion

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The increasing use of laser powder bed fusion (L-PBF) in the manufacture of customized metal implants shows its relevance in healthcare. In this study, Ti-6Al-4V alloy test specimens were manufactured with different orientations by L-PBF (RenAM 500S, Renishaw) from pre-alloyed powder with reuse of 3 and 40 times, a group of which was heat-treated. The O and N contents in the specimens were determined by fusion in inert gas. The density of the specimens was determined using the Archimedes method. The microstructural characteristics of the specimens were evaluated by microscopy and X-ray diffraction techniques, while their mechanical properties were evaluated by tensile testing. The O and N contents in the specimens were higher when the powder with the highest number of reuses was used. The specimens showed high densification (>98%) with no cracks regardless of the number of powder reuses. The specimens printed in different orientations presented similar mechanical properties to each other for each raw powder condition. Product of martensitic decomposition (to alpha + beta), the heat-treated specimens presented lower mechanical strength and greater elongation than the specimens in the as-built condition, being these that met the requirements of the ASTM F2924-14 standard. It was found that the powder reused more times in the L-PBF process increases the mechanical strength of the specimens to the detriment of their elongation, which became evident after heat treatment.