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Influence of Processing Parameters in Selective Laser Melting on the Microstructure and Mechanical Properties of Ti/Tin Composites With in-situ and ex-situ Reinforcement

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Abstract : Selective laser melting is one of the most commonly used AM techniques. In it, a thin layer of metallic powder is deposited, and a laser is used to melt selected zones. The accumulation of layers, each one molten in the preselected zones, gives rise to the formation of a 3D sample with a nearly arbitrary design. To ensure that the properties of the final parts match those of the powder, all the process is carried out in an inert atmosphere, preferentially Ar, although this gas could be substituted. Ti6Al4V alloy is widely used in multiple industrial applications such as aerospace, maritime transport and biomedical, due to its properties. However, due to the demanding requirements of these applications, greater hardness and wear resistance are necessary, together with a better machining capacity, which currently limits its commercialization. To improve these properties, in this study, Selective Laser Melting (SLM) is used to manufacture Ti/TiN metal matrix composites with in-situ and ex-situ titanium nitride reinforcement where the scanning speed is modified (from 28.5 up to 65 mm/s) to study the influence of the processing parameters in SLM. A one-step method of nitriding the Ti6Al4V alloy is carried out to create in-situ TiN reinforcement in a reactive atmosphere and it is compared with ex-situ composites manufactured by previous mixture of both the titanium alloy powder and the ceramic reinforcement particles. The microstructure and mechanical properties of the different Ti/TiN composite materials have been analyzed. As a result, the existence of a similar matrix has been confirmed in in-situ and ex-situ fabrications and the growth mechanisms of the nitrides have been studied. An increase in the mechanical properties with respect to the initial alloy has been observed in both cases and related to changes in their microstructure. Specifically, a greater improvement (around 30.65%) has been identified in those manufactured by the in-situ method at low speeds although other properties such as porosity must be improved for their future industrial applicability.

Keywords : in-situ reinforcement, nitriding reaction, selective laser melting, titanium nitride
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