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Review on direct metal laser deposition manufacturing technology for the Ti-6Al-4V alloy

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ABSTRACT:

Direct laser metal deposition (DLMD) is a breaking edge laser-based additive manufacturing (LAM) technique with the possibility of changing the perception of design and manufacturing as a whole. It is well suitable for building and repairing applications in the aerospace industry which usually requires high level of accuracy and customization of parts; this technique enables the fabrication of materials known to pose difficulties during processing such as titanium alloys. Ti-6Al-4V, which is the most employed titanium-based alloy is one of the materials that are most explored for additive manufacturing process. However, this process is currently at its pioneer stage and very little is known about the fundamental metallurgy and physio-chemical basis that govern the process. Currently, the major problems faced in additive manufacturing include evolution of residual stresses leading to deformed parts and formation of defects such as pores and cracks which are detrimental to the quality of deposits. The presence of these unwanted defects on additively manufactured parts depends on the complex mechanisms taking place in the melt pool during melting, cooling, and solidification which are dependent on processing variables. In addition, during fabrication, some feedstock powder does not melt and thus does not make up part of the final product. The present text entails classification of LAM technologies, operational principles of DLMD, feedstock quality requirements, material laser interaction mechanism, and metallurgy of Ti-6AL-4V alloy.