Microhardness profiling of Ti-6Al-4V components repaired through multiple laser additive re-melt technique

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Abstract

Outstanding properties inherent to Ti-6Al-4V have made it become an aerospace metal work horse and a metal giant in the titanium industry where it constitutes about 60% of titanium alloy usage. However, these properties can be influenced by high temperature processes like laser additive manufacturing (LAM). LAM is a solid free-form fabrication and a materials and process parameters dependent technique that generates solid components from computer aided design (CAD) files by using a laser beam to locally melt the powder and the substrate. In this work, LAM was used to repair narrow rectangular cracks in Ti-6Al-4V plates of 99.6 % purity by depositing similar grade Ti-6Al-4V powder and incorporating multiple laser re-melt treatments in between the deposited layers using argon as shielding gas at controlled deposition and re-melt power, gas flow rate, laser spot size, powder feed rate and scanning speed. Multiple laser re-melt treatments were made, each after every two (2) deposition tracks to collapse any irregularly deposited layers present within the groove, densely fusing the melted powder with the substrate and this was maintained until the multiple deposited welds filled up the cracks. The present work therefore investigates the effects of the multiple laser re-melt treatments on the microhardness of the laser additive repaired components. The obtained results show that laser re-melt treatments induced reheat effects onto the welds which generated a fine $\alpha+\beta$ martensitic structure within columnar prior beta grains and consequently enhanced the microhardness properties in both the heat affected zones and the fusion zones of the welds made.