World Academy of Science, Engineering and Technology
International Journal of Mechanical and Materials Engineering
Vol:15, No:10, 2021

Microstructural Evolution of an Interface Region in a Nickel-Based Superalloy Joint Produced by Direct Energy Deposition

Authors : Matthew Ferguson, Tatyana Konkova, Ioannis Violatos

Abstract : Microstructure analysis of additively manufactured (AM) materials is an important step in understanding the interrelationship between mechanical properties and materials performance. Literature on the effect of laser-based AM process parameters on the microstructure in the substrate-deposit interface is limited. The interface region, the adjoining area of substrate and deposit, is characterized by the presence of the fusion zone (FZ) and heat-affected zone (HAZ), experiencing rapid thermal gyrations resulting in thermal-induced transformations. Inconel 718 was utilized as work material for both the substrate and deposit. Three blocks of Inconel 718 material were deposited by Direct Energy Deposition (DED) using three different laser powers, 550W, 750W and 950W, respectively. A coupled thermo-mechanical transient approach was utilized to correlate temperature history to the evolution of microstructure. The thermal history of the deposition process was monitored with the thermocouples installed inside the substrate material. The interface region of the blocks was analyzed with Optical Microscopy (OM) and Scanning Electron Microscopy (SEM), including the electron back-scattered diffraction (EBSD) technique. Laser power was found to influence the dissolution of intermetallic precipitated phases in the substrate and grain growth in the interface region. Microstructure and thermal history data were utilized to draw conclusive comparisons between the investigated process parameters.

Keywords : additive manufacturing, direct energy deposition, electron back-scattered diffraction, finite element analysis, inconel 718, microstructure, optical microscopy, scanning electron microscopy, substrate-deposit interface region
Conference Title : ICWAM 2021 : International Conference on Welding and Additive Manufacturing
Conference Location : Athens, Greece
Conference Dates : October 21-22, 2021