Deposition Path Strategies in Directed Energy Deposition of Thin Wall 316L-In718 Functionally Graded Material

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Directed energy deposition (DED) of metal powder is an additive manufacturing process capable of creating metallic structures of significant complexity. When feeding a time-dependent chemical composition of powder, functionally graded materials (FGMs) can be produced. One of the desirable material combinations is 316L stainless steel and Inconel 718 due to potential use in turbomachinery, combustion engines, and oil refining [1]. However, metallurgical defects occurring during deposition process severely compromise its mechanical properties. Although defect mitigation by optimizing DED process parameters has been researched, little attention has been paid to deposition strategy optimization. In this study the effect of deposition path strategy on metallurgical defect occurrence in thin-wall 316L-In718 FGMs is investigated. For this purpose, unidirectional (UD), bidirectional (BD) and segmented bidirectional (SBD) [2] deposition was performed. Same process parameters, linear composition gradient and layer deposition time were used in all three cases. Microscopy of sample cross-sections revealed significant differences in cracking: widespread cracks in the UD sample, less cracks in the SBD sample, and only one crack in the BD sample. Cracks in BD and SBD samples were short and oriented differently compared to UD sample. In all samples, the cracks were aligned with columnar dendrite orientation that depended on the strategy used. Energy dispersive spectroscopy was used to analyze chemical composition of the BD sample and revealed no sharp transitions between the layers, indicating good bonding. Presented results confirm that the choice of deposition path deposition strategy significantly affects metallurgical defect occurrence in thin wall 316L-In718 FGMs produced by DED.

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2. M. P. Sefidi, R. Israr, J. Buhl, M. Bambach, *Rule-based path identification for direct energy deposition*. *Procedia Manufacturing*, **2020**, 47, 1134–1140.