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PROCEEDINGS

Effects of Hatch Spacing on Pore Segregation and Mechanical Properties During Blue Laser Directed Energy Deposition of AlSi10Mg

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ABSTRACT

Hatch spacing is a crucial parameter for achieving superior mechanical properties during the process of laser directed energy deposition (L-DED) process. However, the optimum hatch spacing is based on trial and error approaches using pre-existing experience. In this paper, we have systematically compared the porosity characteristics, microstructure evolution, and thermal gradients in double tracks of AlSi10Mg under various hatch spacings during blue laser directed energy deposition (BL-DED). A peculiar phenomenon of pore segregation is observed at the boundary of the overlapping zone of adjacent deposited tracks, where the porosity is almost 8 times that of other areas in the molten zone. Pore segregation consistently exists under different hatch spacings, with 90% of the pores being below 10 μm in diameter. As the hatch spacing increases, the occurrence of pore segregation reduces significantly within the double tracks. Pore segregation tends to occur more frequently at the boundaries of Si eutectic networks due to the cellular growth pattern of α-Al in the solidification process, which pushes the pores towards the Si-based eutectics. The electron backscatter diffraction results reveal that the grain orientations of the double tracks are closely aligned with the <101> direction, and the overlapping area exhibits a mixing characteristic of fine equiaxed and columnar grain structures along the building direction. The BL-DED AlSi10Mg parts exhibited an ultimate tensile strength of 400±4 MPa with minimum pore segregation under the hatch spacing of 1.6 mm (80% of the width of the single track). This study provides a novel insight into the hatch spacing during BL-DED and the relationship among pore defects, developed Si eutectic networks, and solidification structures. It also challenges the conventional selection strategies for hatch spacing and suggests potential enhancements in the quality and mechanical characteristics of BL-DED fabricated parts.

KEYWORDS

Blue laser directed energy deposition; hatch spacing; pore segregation; synchrotron radiation computed tomography

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