Numerical simulation of temperature fields during WAAM production of an aluminium part

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Wire arc additive manufacturing (WAAM) is a notably promising direct energy deposition (DED) technology for the production of large-scale metallic components of various shapes without the need for complex tooling, molds, or dies. The main advantages of this technology include high material efficiency, lead time reductions, a high deposition rate, and low production costs [1-2]. WAAM offers numerous benefits for a wide range of metallic materials, including metals with high reflectivity like aluminum, copper, and magnesium, and their alloys [2-4].

The paper investigates the thermal cycles and temperature fields that develop during the additive manufacturing of an AA5087 aluminum alloy part using conventional Cold Metal Transfer (CMT) with varying deposition parameters. Thermal cycles were experimentally measured using an Ahlborn Almemo 5690-2 measuring station equipped with K-type thermocouples, while temperature fields were captured with a FLIR E95 infrared camera. A simulation model of the deposition process was developed to study the effect of deposition parameters on temperature distribution and the geometrical characteristics of weld beads. Results from numerical simulations using ANSYS software were compared with the macrostructural features and weld bead dimensions in single layers.

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[1] Y. Li, Ch. Su and J. Zhu, Results Eng. 13 (2022) 100330.

[2] H Pant et al. Int. J. Adv. Manuf. Technol. 127 (2023) 4995–5011.

[3] K E K Vimal, M Naveen Srinivas and S Rajak, Mater. Today Proc. 41 (2021) 1139.

[4] M. Maleta et al. Materials 17 (2024) 50.