Journal of
Electrical Engineering and Electronic Technology

Abstract

Microstructural and geometric characteristics investigation of laser-aided direct metal deposition

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Abstract:
Laser-aided direct metal deposition (LADMD) is one of Additive Manufacturing (AM) methods in which the injection of metal powder simultaneously happens with the irradiation of laser beam and layer-by-layer metal deposition is applied. LADMD is a suitable method that can be used to fabricate and repair complex design components without any formative tools. In this study, LADMD of different metal alloys such as superalloys, Ti-6Al-4V, MCrAlY was studied and the dependency of geometric characteristics (the height, width, dilution and wetting angle of single-track deposits) on key process parameters (laser power, scanning speed, and powder feeding rate) were investigated. Microstructure evolution during LADMD is one of the most important factors defining the mechanical behaviours and industrial application. In this research, a finite element model is developed to simulate the evolution of the nucleation and grain growth during LADMD solidification. The results showed that the geometric characteristics had a linear relationship with a combined parameter including three/two key process parameters together. Process maps are developed to enable optimization of the process parameters in LADMD process of different metal alloys. Numerical calculations and experimental observations reveal the dependence of heat transfer, solidification conditions and grain structure evolution on process parameters. In LADMD, changes in primary dendrite arm spacing (PDAS) and secondary dendrite arm spacing (SDAS) is not very dependent on the scanning speed. When scanning speed and G/R ratio decrease, constitutional undercooling at the last stage of solidification increases, and columnar to equiaxed transition are present in the region near the top of the deposited layer. As well as, fine columnar dendrite arm spacing under a high scanning speed and high G/R ratio tends to produce. The calculation results of Heat transfer and grain evolution are in good agreement with the experimental data.

Biography:
Professor Reza Shoja Razavi studied Materials Science and Engineering at Tarbiat Modares as MSc in 2001. He then joined the research group of Professor M. Salehi at Isfahan University of Technology. He received his PhD degree in 2007 at the same University. He also had the opportunity to study under the supervision of Professor H. C. Man at The Hong Kong Polytechnic University on two separate sabbatical periods. He obtained the position of a Professor in laser materials processing at the Malek Ashtar University of Technology. He has published more than 140 research articles in SCI(E) journals and also seven Books. He is vice-president of the Iranian Society of Surface Science and Technology (ISSST)

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15th International Conference on Laser Advanced Materials Processing , June 22-23, 2020, Osaka, Japan

Citation: Reza Shoja Razavi, Microstructural and geometric characteristics investigation of laser-aided direct metal deposition, June 22-23, 2020, Osaka, Japan