World Academy of Science, Engineering and Technology
International Journal of Mechanical and Industrial Engineering
Vol:18, No:08, 2024

Simulation of Single-Track Laser Melting on IN718 using Material Point Method

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Abstract : This paper describes the Material Point Method (MPM) for simulating a single-track laser melting process on an IN718 solid plate. MPM, known for simulating challenging multiphysics problems, is used to model the intricate thermal, mechanical, and fluid interactions during the laser sintering process. This study analyzes the formation of single tracks, exploring the impact of varying laser parameters such as speed, power, and spot diameter on the melt pool and track formation. The focus is on MPM's ability to accurately simulate and capture the transient thermo-mechanical and phase change phenomena, which are critical in predicting the cooling rates before and after solidification of the laser track and the final melt pool geometry. The simulation results are rigorously compared with experimental data (AMB2022 benchmarks), demonstrating the effectiveness of MPM in replicating the physical processes in laser sintering. This research highlights the potential of MPM in advancing the understanding and simulation of melt pool physics in metal additive manufacturing, paving the way for optimized process parameters and improved material performance.

Keywords : dditive manufacturing simulation, material point method, phase change, melt pool physics
Conference Title : ICMSAM 2024 : International Conference on Modeling and Simulation for Additive Manufacturing
Conference Location : Amsterdam, Netherlands
Conference Dates : August 05-06, 2024