PROBABILISTIC SIMULATION OF SOLIDIFICATION TEMPERATURE AND MORPHOLOGY EVOLUTION DURING LASER-BASED METAL DEPOSITION

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ABSTRACT
A predictive model, based on a Cellular Automaton (CA) - Finite Element (FE) method, has been developed to simulate microstructure evolution during metal solidification for a laser based additive manufacturing process. The macroscopic FE calculation was designed to update the temperature field and simulate a high cooling rate. In the microscopic CA model, heterogeneous nucleation sites, preferential growth orientation and dendritic grain growth kinetics were simulated. The CA model was able to show the entrapment of neighboring cells and the relationship between undercooling and the grain growth rate. The model predicted the dendritic grain size and morphological evolution during the solidification phase of the deposition process. Model parameters for the simulations were based on stainless steel 316 (SS316).