Numerical Prediction of Microstructures Properties during Laser Beam Melting of Single-track 316L Stainless Steel

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Additive processes are more and more frequently used for the creation of objects. Indeed, they offer the possibility to reduce material waste and manufacturing time, and enable the creation of structures with complex geometry. Nevertheless, these processes create anisotropy in the manufactured object linked to its microstructural characteristics, influencing consequently the final mechanical properties of the part. This anisotropy is mainly due to process parameters.

In this context, the aim of this study is to model grain structure formation during Laser Beam Melting (LBM) and to identify links between manufacturing parameters and resulting microstructures. Numerous factors influence the microstructure formation, such as the powder characteristics, the laser parameters or the building strategy. To limit the number of involved factors, we focus on parameters related to the heat source characteristics (scanning speed, laser power, focus diameter).

An approach combining experimentation and simulation is adopted. A numerical modelling based on a three-dimensional "CAFE" model, which couples Cellular Automaton (CA) and Finite Element (FE) simulations, is used in order to predict grain formation during the construction of the part. The numerical modelling is defined from instrumented experimentations and is validated comparing the thermal field evolutions, the size and shape of the molten zone, and finally the grain structure resulting from simulations with experimental results.

Finally, we discuss simulation results (thermal evolutions and grain characteristics) of single-track samples obtained with different building parameters.