Modeling the Evolution of Grain Texture in Laser-Based Powder Bed Fusion Manufactured Alloy 625

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ABSTRACT

Simulation and modeling can be used together with additive manufacturing (AM) to achieve a "right the first time" approach, resulting in fewer scrapped components and the ability to manufacture complex-shaped components. In laser-based powder bed fusion (PBF-LB), metal powder is melted and solidified into the component being built. The microstructure of the built component evolves during the process and the final microstructure varies depending on the chosen process parameters, resulting in different mechanical properties of the manufactured component. Using modeling and simulation, it is possible to predict the microstructure's evolution, enabling the optimization of the final microstructure to obtain the desired mechanical properties. In this study, a 2D cellular automata and a finite element model (CA-FE) were combined to predict the evolution of the microstructure in alloy 625 made by PBF-LB. The 2D decentered square capture algorithm, developed by Gandin and Rappaz [1], was used to predict the grain growth in the CA model based on the temperature field obtained with the FE model. The CA-FE model was used to predict the microstructure in the cross-section plane where the scan direction is the normal to the plane, as well as in a plane where the build direction is the normal to the plane. The results with the scan direction as normal to the plane show that model can predict the competitiveness of grain growth, the impingement of equiaxed grains, and the extension of columnar grains. Additionally, V-shaped grains were observed, which were previously seen in EBSD maps of AM materials [2]. In the plane where the build direction is normal to the plane, it was observed that the grains tend to align along the scan direction for lower scan velocities. The results demonstrate the potential of the 2D CA-FE model to make accurate predictions of the final microstructure.

REFERENCES

[1] Ch.-A. Gandin, M. Rappaz, *A 3D Cellular Automaton algorithm for the prediction of dendritic grain growth*. Acta Materialia (1997).

[2] Wang et al., *Small punch creep performance of heterogenous microstructure dominated Inconel 718 fabricated by selective laser melting.* Materials & Design (2020).