Finding Optimal Parameter Ranges for Laser Powder Bed Fusion with Predictive Modeling at Mesoscale

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ABSTRACT

We present the results of a 3D modeling of the laser powder bed fusion process on the mesoscale level with an advanced multiphysical numerical tool. High-performance simulation allowed to conduct a vast parametric study. Thus, the model has been extensively verified against experimental results in a large parameter range, and, further, it has been used to construct detailed process maps in the range not covered by the available experimental data.

The analysis of the results that were obtained in the model along with the data in the published research [1] allowed to propose the quantitative criteria for determining the behavior of the track formation. The key phenomena [2, 3] that affect this behavior have been studied. We conclude that the productivity limit that arises with the proportional increase in scanning speed and laser beam power is caused by the spatter ejection. The sensitivity analysis shows that the transition to the spattering regime is caused by the overheating of the meltpool surface layer, and, consequently, the development of the surface instability [3]. The instability development is assumed to be due to the fact that the recoil pressure becomes much higher in comparison with the surface tension.

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