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A Smoothed Particle Hydrodynamics Model for Melt Pool Dynamics in Laser Beam Melting of Ni-based Alloy 718

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Laser Beam Melting (LBM) is an additive manufacturing process which simultaneously involves multiple physical phenomena such as thermo-fluid dynamics, irradiation and phase change. Therefore, an understanding of the significant underlying physical processes and their interaction is very challenging. This problem can be addressed by means of a numerical modeling approach. Within this work a numerical model of LBM based on the meshless computational method Smoothed Particle Hydrodynamics (SPH) is presented. SPH was originally introduced by [1, 7]. Due to its meshless nature and, especially, in multi-phase formulation suggested by [2, 3] it is very convenient for the simulation of additive manufacturing processes such as LBM.

Furthermore, its implementation turns to account the parallelization capabilities of GPGPUs for achieving a reduced computation time. Physical phenomena such as the heat transport due to laser beam radiation, thermal conduction, phase transitions, convection, and effects related to surface tension and thermocapillarity are considered. Approaches for modeling the recoil pressure induced by evaporation are applied - following essentially [6, 5, 4].

The buoyancy due to temperature gradients is taken into account by means of the Boussinesq approximation. The relevant material data for the investigated Ni-based alloy Inconel718® are implemented as a function of temperature and the required values are taken from literature [11, 9, 10, 8].

The simulation results are compared with experimental data of single melt tracks to evaluate the validity of the model with regard to the process parameters (e.g. scanning velocity, laser power).

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