A welding model for additive manufacturing (SLM) analysis

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ABSTRACT

Additive manufacturing processes as Selective Laser Melting (SLM) are more and more used in industrial context. The advantages of these processes are mainly related to the capability to produce a small or medium number of complex pieces without material removing and tools. Nevertheless, the processes remain difficult to master. For instance, SLM process, has a lot of setting parameters as laser power, beam diameter, feeding rate, hatch length or beam trajectory. Moreover, material properties have also a strong influence in the resulting build shape as heat accumulation, mechanical stress and strain. The defects occurring during process are mainly melt or powder ejections, flow instabilities and residual porosities.

One of the methodology to improve the process is the addition of numerical analysis to experiment, in which the vision of the small melt pools remains quite hard today. The particularity of the numerical analysis is the capability to observe phenomena independently. The difficulty is the ability to simulate the whole phenomena in this complex setup where vapour, liquid, solid and powder interact together. Complete models considering the whole phases can be found in literature but they are quite complex and very long to compute. A meso-scale analysis can also be done by considering the powder phase as a continuous phase with equivalent properties. The strength of these models is the simplicity of the simulation and the capacity to predict the elementary "weld seam" shape including flow instabilities but defects as ejections cannot be simulated.

In the present work, authors present another meso-scale analysis based on laser micro-welding models with "filler material" allowing to neglect the powder phase and to consider it as an input parameter. This "reduced" model will be compared for different parameter sets to experimental results and an analysis of its validity will be done.