Influence of particle size and distribution in numerical modelling of Selective Laser Melting

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ABSTRACT

The purpose of this work is to develop a multiphase solver for the modelling of melting and flow of metal powder particles during the Selective Laser Melting (SLM) process cycle. SLM is a free-form manufacturing technique where initially a thin layer of powder is deposited on a bed. A laser beam then scans the powder, thus melting and fusing the powder particles together. After the scan is complete, a new layer is deposited and the process repeats. Melt pool dynamics and subsequent crystallization have significant impact on the mechanical properties of an additively manufactured part. Numerical modelling of SLM can aid in understanding the underlying physical phenomena. The powder bed is discrete and randomly packed, which if neglected can lead to an unrealistic symmetrical melt track [1]. To account for the stochastic nature of the powder bed, Discrete Element Method (DEM) is used to model the powder deposition. The powder particles are then transferred onto Finite Volume Mesh to solve the heat transfer and flow equations using OpenFOAM. Volume of Fluid (VOF) approach is used to model the flow in the system while an extended version of solidification phase change model by Voller et al. [2] is employed to solve the energy equation. Laser irradiation is included by solving Radiation Transfer Equation (RTE) using Discrete Ordinate (DO) method and introduced as source terms in the energy equation [3]. Numerical benchmarks such as Bubble rise problem, Stefan problem and 2-D Gallium melting are employed to verify the implementation of the above mentioned mathematical models. Influence of the particle size distribution on the shape and size of melt tracks are then investigated. The results obtained from this study can provide better understanding of powder bed modelling of SLM process.

REFERENCES

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