A Powder Resolving DEM-CFD Approach in Additive Manufacturing

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ABSTRACT

Metal additive manufacturing methods convince through their freedom in design that is not reached by conventional subtractive manufacturing. Directed energy deposition technologies for additive manufacturing such as laser selective melting (SLM) or electron beam melting (EBM) is a fast growing technique mainly due to its flexibility in product design. However, the process is a complex interaction of multi-physics on multiple length scales that are still not entirely understood because a wide range of processes such as fluid dynamics, thermodynamics including phase change, metallurgy to name a few is involved. Therefore, numerical techniques are gaining impact and become complementary to experimental work. An analysis of detailed results leads to a deeper understanding of the underlying physics and consequently to a better design. Therefore, the objective is to describe numerically the complex interaction between melting powder particles due to a laser beam and the fluid dynamics of the liquid molten material.

In order to include both several physical processes and length scales an Euler-Lagrange technology is applied referred to as the Extended Discrete Element Method (XDEM) [1, 2]. Within this framework powder is treated by the Discrete-Element-Method, that provides position, thermodynamic state and morphology information for each particle. The gas and liquid flow is described by resolved and tailored multiphase Computational Fluid Dynamics (CFD). Both, particulate and continuous phases i.e. powder particles and liquid are coupled through an exchange of mass, heat and momentum. The described method succeeded in delivering more accuracy and consistency than a standard approach based on the volume averaging technique. The presented qualitative validations show the applicability of the concept to LPBF processes such as Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), and Electron Beam Melting (EBM).

REFERENCES

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