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Developing a DEM-Coupled OpenFOAM Solver for Multiphysics Simulation of additive Manufacturing Process

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Powder-based additive manufacturing technologies, specifically selective laser melting, are challenging to model due to the complex, interrelated physical phenomena that are present on multiple spatial scale, during the process. A key element of such models will be the detailed simulation of flow and heat transfer throughout the melt pool that is formed when the powder particles melt. Due to the high temperature gradients that are rised inside the melt pool, Marangoni force plays a key role in governing the flows inside the melt pool and deciding its shape and dimensions[1]. On the other hand the mass and heat transfer between the melt and the powder also has a signifacnt role in shaping the melt pool at the edges.

In this study we modified an OpenFOAM solver(icoReactingMultiphaseInterFoam) coupled with an in-house developed DEM code known as eXtended Discrete Element Method or XDEM which models the dynamics and thermodynamics of the particles[2]. By adding the Marangoni force to the momentum equation and also defining a laser model as a boundary Condition for Liquid-Gas Interface, the solver is capable of modeling selective laser melting process from the moment of particle melting to the compeltion of the solidified track. The coupled solver was validated with an ice packed bed melting case and was used to simulate a multi-track selective laser melting process.

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