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Hybrid discrete element and raytracing framework for the analysis of powder-bed additive manufacturing

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Nowadays, a variety of materials can be 3D printed with an increasingly higher quality and precision. Although significant progress has been made in the development of Additive Manufacturing (AM) techniques, experience obtained from previous print jobs is still heavily relied on. Numerical simulations can provide fundamental understanding of the AM processes and can be used for the prediction or correction of phenomena that produce undesired product shapes or properties.

To gain insights into complex multi-physics AM processes, a Discrete Element Method (DEM) framework is developed [1]. This framework aims to capture the required physics to predict the macroscopic continuum properties of the product. The DEM framework includes distinct models for the mechanical and thermodynamic behaviour of the powder as well as the solid material. An material addition method is used to produce representative powder layers and a heatsource is included. Combining these aspects together with thermo-mechanical coupling and bonding kinematics enables full-process simulation of AM.

In order to study the laser heatsource effects more meticulously, a raytracing framework is developed [2]. The raytracing framework captures the main physics of the powder and light ray interaction. The results of the raytracing simulations are used to improve the heatsource implementation of the DEM framework.

To investigate the effects of laser settings and powder properties on the laser-powder interaction raytracing simulations are performed. Using the DEM framework a case study is performed to investigate the effects of printer settings and powder properties on the printing process.

REFERENCES

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