Bachelor/Master Thesis

Simulation of Additive Manufacturing by the Particle Finite Element Method

Für Herrn / Frau XXX (Matrikel-Nr. XXXXX)

TECHNISCHE UNIVERSITÄT DARMSTADT

Problem

Laser powder bed fusion (L-PBF) is a metal powder bed based layer-wise additive manufacturing process which enables the manufacturing of industrially-relevant parts with high design complexity. L-PBF offers theferore a high degree of design freedom that promises to unleash a high structural lightweight potential where, among others, cellular mesostructures such as honeycomb or lattice structures find a growing resonance.

In order to use this lightweight potential and exploit it to its greatest extent, the reliable and reproducible manufacturing of these mesostructures is essential. Here, the influence of the energy input is manifold (defects, texturing, residual stresses…). Hence, both heat balance and thermal gradients play a decisive role during the manufacturing process. Particle simulations (P-FEM) enable reproducing the layer-wise manufacturing by simulating melting tracks. This approach can be employed to predict process-dependent heat flows and can therefore help understanding the process-induced mechanical properties of mesoscale features.

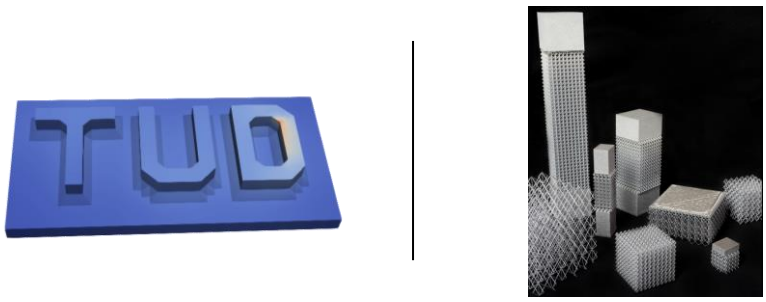

Figure 1: Left:example of P-FEM simulation. Right: additively manufactured lattice structures (KLuB)

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Aufgaben

The aim of this work is the creation of a Particle Finite Element Model that faithfully recreates the L-PBF manufacturing of lattice structures.

Following tasks are planned in the framework of this investigation:

- Literature survey on the state of the art of heat input issues by additively manufactured parts with focus on mesoscale features. Simulation and manufacturing shall be regarded.
- Creation of a model to simulate a layer-wise process dependent heat distribution within a lattice unit cell. Truss-based lattice cells are in focus. Different scanning strategies and corresponding process parameters as well as different build platform temperatures shall be covered.
- Investigation of the heat distribution for different representative unit cells, different scanning strategies, process parameters and build platform temperatures.
- Identification of potential issues for the manufacturing of lattice structures, especially at high height.
- Proposal for heat flux homogenization and according verifications (optional: exploitation of scaling laws).
- Derivation of design and / or manufacturing rules.
- Proof of concept: assessment verification by simulating lattice structure for one specific use case
- Experimental validation of the proof of concept
- Documentation and critical discussion of the results

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Deutscher Titel

Simulation der additiven Fertigung auf Mesoskala