TU Darmstadt | FB 11| Prof. Dr. Bai-Xiang Xu | Otto-Berndt-Str. 3 | D-64287 Darmstadt

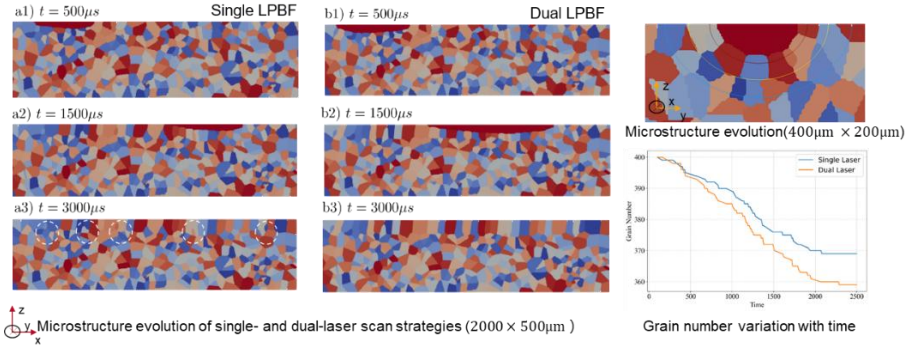
TECHNISCHE UNIVERSITÄT DARMSTADT

ARL / Master Thesis topic available

Phase-Field Modeling of Microstructure Evolution in Additive Manufacturing of Magnetic Materials

at the Division of Mechanics of Functional Materials in the institute of Material Science, TU Darmstadt

Sep. 19, 2025



Microstructure evolution of single- and dual-laser scan strategies ($2000 \times 500\mu m$)

Grain number variation with time

Motivation

Laser powder bed fusion (LPBF) has attracted increasing interest for tailoring the magnetic properties of materials such as Nd-Fe-B and $SmCo_5$, as process parameters strongly affect the resulting microstructure. The phase-field (PF) method provides a thermodynamically consistent approach for simulating microstructure evolution with physically informed parameters. This is particularly important for magnetic materials, where the microstructure directly governs functional performance, making it essential to understand how different scanning parameters and strategies influence grain structure.

Objectives

The aim of this project is to implement and test a PF model of grain growth that explicitly accounts for polycrystalline texture. The work will involve setting up the model in finite element framework, performing selected simulations of microstructure evolution, and analyzing the influence of different LPBF process parameters and scanning strategies on the resulting grain texture, with a particular focus on magnetic materials.

Tasks

- Preparation: Apply to HPC (high-performance computer) for a small project
- Literature review: Study grain growth, with focus on phase-field approaches.
- Model setup: Implement a PF model in an existing finite element framework.
- Simulation study: Perform grain growth simulations to investigate the influence of key LPBF process parameters on polycrystalline texture.
- Validation: Compare results with phase-field models to evaluate different material system.
- Post-processing: Analyze simulation outputs to quantify grain growth kinetics and texture evolution.

Interested? Please Contact:

Dr.-Ing. Yangyiwei Yang, yangyiwei.yang@tu-darmstadt.de; L6/01 420

M. Sc. Yifan Suo, yifan.suo@tu-darmstadt.de; L6/01 401

Technische Universität Darmstadt

Institute of Materials Science

MECHANICS of FUNCTIONAL MATERIALS

Prof. Dr. Bai-Xiang Xu

Otto-Berndt-Straße 3
64287 Darmstadt
Germany

Tel. +49 (0)6151 21906
xu@mfm.tu-darmstadt.de

Dr. -Ing. Yangyiwei Yang

Otto-Berndt-Straße 3
64287 Darmstadt
Germany

Tel. +49 (0)6151 22923
yangyiwei.yang@mfm.tu-darmstadt.de