Technische Universität Braunschweig

GRK 2075 MUSEN

FE-FFT-based multiscale simulations of polycrystalline materials

Lecture of

Jun.-Prof. Johanna Waimann

RWTH Aachen University

October 4, 2023, 4:00 PM

Okerhochhaus, Pockelsstraße 3,

seminar room, ground floor

The behavior of a material is highly influenced by its microstructure. In order to be able to use a material as resource-efficiently as possible, it is important to know its behavior as precisely as possible and to be able to simulate it in a time efficient manner. To capture complex local microstructural effects such as phase transformations or plasticity, we present a two-scale finite element (FE) and fast Fourier transformation-based (FFT) method [1, 2]. We want to present the two-scale method's ability to model highly resolved thermo-mechanically coupled problems and its application in the field of microstructural evolutions in polycrystalline materials, e.g. [4]. Additionally, we show how a model order reduction technique, which is based on an adaptively chosen reduced set of Fourier modes [3], decreases the high computational costs of the FFT-based simulation.

[1] J. Spahn, H. Andrae, M. Kabel, and R. Müller. A multiscale approach for modeling progressive damage of composite materials using fast fourier transforms. Computer Methods in Applied Mechanics and Engineering, 268, 871-883, 2014.

[2] J. Kochmann, J. R. Mianroodi, S. Wulfinghoff, B. Svendsen, and S. Reese. Two-scale, FE-FFT- and phase-field based computational modeling of bulk microstructure evolution and macroscopic material behavior. Computer Methods in Applied Mechanics and Engineering, 305, 89-110, 2016.

[3] C. Gierden, J. Waimann, B. Svendsen, and S. Reese. FFT-based simulation using a reduced set of frequencies adapted to the underlying microstructure, Computer Methods in Material Science 21.1, 51- 58, 2021.

[4] J. Waimann, C. Gierden, and S. Reese. Simulation of phase transformations in polycrystalline shape memory alloys using fast Fourier transforms. Proceeding of ECCOMAS Congress (Scipedia), 1-9, 2022.