Karlsruher Institut für Technologie

Institut für Angewandte Materialien

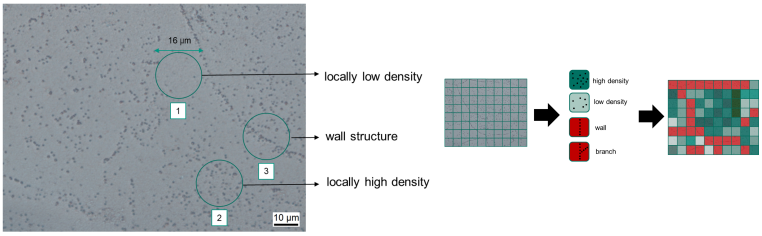
Bachelor-/Master Thesis

# Uncertainty in Crystal Plasticity Simulations and Design Optimizations

## Background

In materials, the existence of random heterogeneity such as dislocation distribution, dual-phase structures, and porous materials poses challenges for realistic simulation at any scale. This thesis focuses on integrating realistic uncertainties into scientific computing workflows for the continuum dislocation dynamic simulation(CDD), a dislocation-based crystal plasticity finite element model.

The research involves incorporating experimentally measured initial material structures (e.g., dislocation density or porosity distribution) and applying random initial conditions to the crystal plasticity modeling. The work begins with analyzing experimental data to identify the random distribution type, followed by implementing a stochastic partial differential equation (SPDE) solver into the simulation model. The main tasks of the work will also include stability analysis of the numerical framework and statistical analysis of the results.




Dislocation distribution from experiments[1] [1] Li, J. (2020).

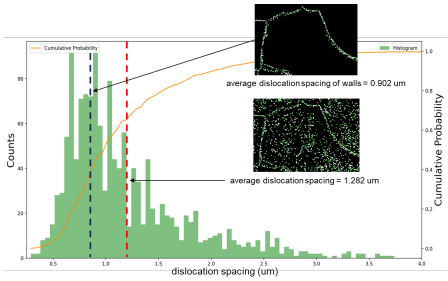
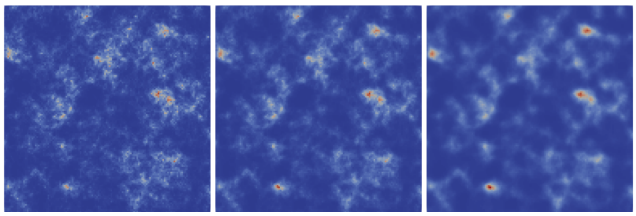
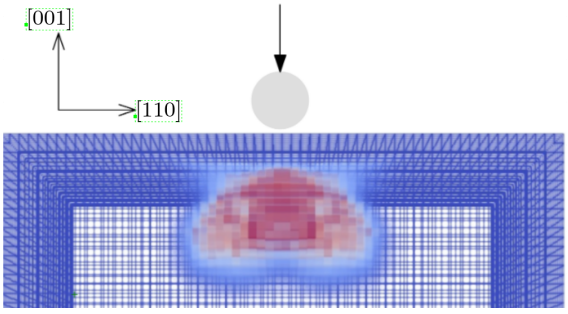



Image analysis for dislocation spacing.



SPDE sampling from M++ library[2]

[2] Baumgarten, N. (2023).




CDD simulation

## Requirements

- Keen interest in numerical computing/simulation with a C++ project.
- Programming knowledge of C++, python, R, and git are advantages.

## Contact

Prof. PD Dr.-Ing. Katrin Schulz
*Institut für Angewandte Materialien — Zuverlässigkeit und Mikrostruktur (IAM-ZM)*
**Email: katrin.schulz@kit.edu**

M.Sc. Sing-Huei Lee
*Institut für Angewandte Materialien — Zuverlässigkeit und Mikrostruktur (IAM-ZM)*
**Email: sing-huei.lee@kit.edu**