

# Multiphase-field modelling of brittle and ductile crack propagation in microstructures

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## ABSTRACT

Cast iron is a widely used material, which can be considered as a natural composite material consisting of a steel-like matrix with graphite inclusions. For truck brake discs, cast iron with lamellar graphite and a pearlitic matrix serves as the base material. During braking, the material must resist a high mechanical load, in which micro-crack formation and growth processes can occur.

The pearlitic matrix is modelled as an isotropic ductile material with  $J_2$ -plasticity, whereas the graphite lamellae are considered to be brittle with an elliptical anisotropy. In the diffuse solid-solid interface the mechanical model is based on the mechanical jump conditions [1]. The phase-field model for crack propagation in multiphase systems which is used in this work originates from Schneider et al. [2]. Validation examples for the anisotropic crack propagation are presented. Finally a realistic cast-iron structure is considered to demonstrate the capabilities of the multiphase-field model [3].

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## REFERENCES

- [1] C. Herrmann, E. Schoof, D. Schneider, F. Schwab, A. Reiter, M. Selzer, B. Nestler, Multiphase-field model of small strain elasto-plasticity according to the mechanical jump conditions. *Computational Mechanics* (2018) 1–14
- [2] D. Schneider, E. Schoof, Y. Huang, M. Selzer, B., Nestler. Phase-field modeling of crack propagation in multiphase systems. *Computer Methods in Applied Mechanics and Engineering* (2016) **312**:186-195
- [3] C. Herrmann, D. Schneider, E. Schoof, F. Schwab, B. Nestler. Multiphase-field model for the simulation of brittle and ductile crack propagation in grey cast iron microstructures. *in preparation*