

# MICROMECHANICAL MODELLING OF FATIGUE CRACK INITIATION IN MARTENSITIC HIGH STRENGTH STEELS

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## Abstract:

Martensitic high strength steels are of crucial importance regarding highly loaded components of sustainable future mobility solutions. In order to ensure reliability requirements of these parts, the dominant failure mechanism has to be understood which is fatigue. The fatigue crack initiation phase represents a significant proportion of the total fatigue life and is strongly influenced by the underlying complex hierarchical microstructure. There are already numerous research works, focusing on fatigue crack initiation and crack growth for martensitic steels experimentally. However, modelling fatigue crack initiation for these steels is still an unsolved challenge in the scientific community.

In this work, a numerical study presents important macroscopic as well as microscopic investigations, considering the fatigue crack initiation behaviour in the low-cycle and high-cycle fatigue regime on the example of the martensitic steel 50CrMo4 (1.7228). In the framework of a multiscale micromechanical model using a crystal plasticity model, a new approach is developed to identify crystal plasticity model parameters on basis of micromechanical simulations and experimental data. Furthermore, the effect of different kinematic hardening models is investigated with respect to mean stress relaxation as well as on fatigue crack initiation behaviour. Therefore, fatigue simulations are performed with synthetically generated representative volume elements (RVE), containing the hierarchical microstructure of tempered lath martensite. In addition, different fatigue indicator parameters which represent a measure for fatigue damage are applied and evaluated, concerning the applicability at different strain and stress ratios. Finally, the numerical representative results are compared to experimental fatigue results.

## Keywords:

fatigue crack initiation, martensitic steel, multiscale modelling, crystal plasticity, kinematic hardening models, fatigue indicator parameter

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