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A COMPARISON OF APPROACHES TO MODEL ANISOTROPY EVOLUTION IN PEARLITIC STEEL

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In this contribution a model, tailored for a pearlitic steel, based on the framework of computational homogenization is used to study the impact of altering the type of homogenization scheme on the resulting stress response. The starting point in the employed multiscale model is two different types of micromodels which are calibrated to experimental data from micro-pillar testing.

On the subscale of a pearlitic steel brittle cementite lamellae embedded in a ductile ferrite matrix are observed. The cementite lamellae appear in grains (or colonies) within which a privileged orientation of the cementite lamellae can be identified. This composite-like constitution makes pearlitic steels ideally suited for computational homogenization.

As a means to model the interactions between the ferrite and the cementite two different micromodels (denoted μ_i and μ_{i+1}) are considered, see fig. 1. Micromodel μ_i, as proposed in [2], is based on a Representative Volume Element (RVE) subjected to periodic boundary conditions. The geometry of the RVE is such that an analytical solution of the homogenized response is possible. Micromodel μ_{i+1} is based on the assumption that the plastic flow is dominated by the shearing of the ferrite between the cementite lamellae. This assumption is motivated by the fact that the cementite is harder than the ferrite and that the cementite has a higher elastic limit. Both of these micromodels are calibrated against experimental data from micro-pillar testing with varying cementite lamella orientations.

On the mesoscale grains with different cementite lamella orientations interact. This mechanism is taken into account in two different mesomodels (denoted γ_i and γ_{i+1}) which are based on different homogenization assumptions. In mesomodel γ_i a voronoi triangulation [3] is used to represent the pearlite colonies and their orientations. Two different prolongation conditions are considered, Taylor (γ_i^T) and Dirichlet (γ_i^D). In the second mesomodel (γ_{i+1}) an analytical homogenization scheme [1] using ODF-based integration in spherical coordinates is used. In this model an areal-affine type of re-orientation is assumed.

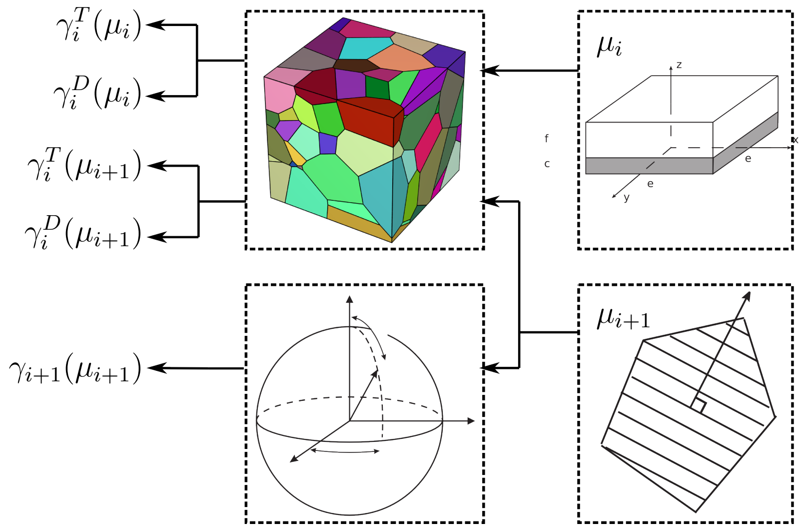

Figure 1: Shematic figure of the different homogenization schemes employed in the present contribution.

Using the above listed models the impact of using different types of homogenization schemes on the resulting macroscopic stress response will be studied. It is remarked that the micromodels will be calibrated to experimental data.

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