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Prediction of the mechanical behaviour of pearlitic steel based on microcompression tests, micromechanical models and homogenization approaches

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Abstract

In this paper, results from microcompression tests on pearlitic steel pillars are used to determine properties of cementite and ferrite. Pillars with different orientation of the cementite lamellae have been tested to distinguish model parameters of cementite and the ferrite in two different micromechanically based models of pearlite. Both models are based on the assumption that the yielding is primarily caused by shear of the ferrite between the cementite lamellae. In the first of these models the cementite and ferrite are modelled individually. The second model is a mesomodel of a cementite lamella together with the surrounding ferrite. Based on these micromechanically based models different homogenization approaches are adopted to obtain the macroscopic behaviour of pearlitic steel. During deformation of the pearlitic steel anisotropy evolves which is assumed to be governed by the re-orientation of the cementite lamellae during the deformation. The most fundamental homogenization approach that is studied is a 3D grain structure where the fluctuating displacement field within the grain structure is solved by using Finite Element Method (FEM). The re-orientation of the cementite lamellae is governed by the deformation of the grain structure. In the investigated analytical homogenization approaches the re-orientation is assumed to follow the areal affine assumption where the normals of the cementite lamellae are convected with the macroscopic deformation gradient. Numerical results for the different models and homogenization approaches, when subjected to simple shear loading, are given and comparisons of