Modeling finite strain martensitic phase transformation for low carbon dual phase steels

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ABSTRACT

Modeling the transformation behavior of metallic materials due to thermal and mechanical loading is of great importance considering a variety of production processes and structural components. Prominent examples are high strength steels and shape memory alloys. Existing models describing the kinetics of phase transformations are either phenomenological models using empirical evolution equations, e.g. [1], or micromechanical models. Of the latter there are essentially two different types. The first type considers diffuse interface models based on a phase field approach, e.g. [2]. The second type are sharp interface models as for example in the context of an inclusion problem [3] or based on energy relaxation, e.g. [4].
The present work is concerned with the thermomechanical austenite-martensite transformation behavior of the low- carbon dual phase steel DP 600. To capture the transformation kinetics in terms of a sharp interface theory according to [5] a Rank-1 energy relaxation of the underlying free energy using Rank-2 laminates is applied, e.g. [6].
To account for large transformation strains accompanied by large rotations, a thermomechanical finite-strain framework is established. Additionally, plastic yielding of the austenite and different martensite phases is incorporated.
Numerical examples examining the effect of different load and temperature scenarios on the transformation kinetics are discussed. Furthermore, the finite element implementation using the UMAT-interface of Abaqus is considered and numerical examples are presented.

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