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SIMULATION OF UPPER AND LOWER BAINITIC TRANSFORMATION IN A UNIFIED PHASE FIELD MODEL

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The bainitic transformation is one of the most complex transformations in steel. The transformation from austenite to bainitic ferrite is assumed to be displacive [1] in contrast to the perlitic growth which is highly dependent on the carbon movement and therefore is ranked as a diffusive transformation. However, regarding the whole microstructure named bainite, consisting of bainitic ferrite, carbides and (residual) austenite, the movement of the carbon is of major importance. The displacive growth of the bainitic ferrite leads to a supersaturated phase. In lower bainite the carbon within the ferrite separates [1] and precipitates as carbides. In upper bainite the carbon leaves the supersaturated bainitic ferrite and diffuses across the interface into the austenite. This may lead to carbides close to the interface between ferrite and austenite but may also stop the transformation from austenite to bainitic ferrite and produce residual austenite.

In this work the phase-field method is utilized to simulate the phase transformations of upper and lower bainite, including the phase transition from austenite to bainitic ferrite and the precipitation of carbides [3]. The phase-field equations are coupled to a diffusion equation governing the carbon concentration. The underlying system of partial differential equations is based on a thermodynamic framework of generalized stresses for a two phase Ginzburg-Landau system and a Cahn-Hilliard equation. We extend this framework for multiphase-field models coupled to a viscous Cahn-Hilliard equation [2] with diffusion across the interface. The numerical examples show the qualitative mechanism of the upper and the lower bainitic transformation unified in a model as discussed above [3].

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