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Partitioning kinetics of alloying elements in a medium Mn steel during Q&P treatments using phase field modelling

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The Quenching and Partitioning process provides steels with an improved combination of strength and ductility when compared with other advanced high strength steels. This processing route involves several steps in which a complex microstructural development takes place. The microstructural development during the Q&P process has been studied in the past with 2D phase field modelling including only aspects related to carbon partitioning, where the partitioning kinetics of substitutional alloying elements have been neglected. This work investigates, for the first time, the partitioning kinetics of carbon, manganese and silicon in a medium Mn steel during the Q&P treatments using multi-phase field modelling. The redistribution of the interstitial and the substitutional elements between martensite ($\alpha^{|}$) (described as acicular ferrite) and austenite (γ) phases is studied under different partitioning conditions. Investigations show that the homogenization times of carbon in the austenite strongly depends on the grain size and partitioning temperatures. Partitioning of manganese and silicon is observed to happen at much higher partitioning temperatures and times compared to carbon. Silicon is enriched on the martensite ($\alpha^{|}$) side of the $\alpha^{|}/\gamma$ interface, indicating the chances of carbide formation in the austenite region. Results from this research provides an understanding of the microstructural development during the application of Q&P heat treatments that is difficult to gain solely with the experiments.

Keywords: Phase field modelling, Quenching & Partitioning, Partitioning kinetics