Abstract

Spatial distribution in size and frequency of microalloy precipitates have been characterised in two continuous-cast HSLA steel slabs, one containing Nb, Ti, and V and the other containing only Ti. Micro-segregation during casting resulted in an inhomogeneous distribution of Nb and Ti-precipitates in as-cast slabs. A model has been proposed here, based on the detailed characterization of cast microalloy precipitates, for predicting the spatial distribution in size and volume fraction of precipitates. The present model considers different models, which have been proposed earlier. Micro-segregation during solidification has been predicted from the model proposed by Clyne and Kurz. Homogenization of alloying elements during cooling of the cast slab has been predicted following the approach suggested by Kurz and Fisher. Thermo-Calc software® predicted the thermodynamic stability and volume fraction of microalloy precipitates at interdendritic and dendritic regions. Finally, classical nucleation and growth theory of precipitation have been used to predict the size distribution of microalloy precipitates at the above mentioned regions. The accurate prediction and control over the precipitate size and fractions may help in avoiding the hot-cracking problem during casting and selecting the processing parameters for reheating and rolling of the slabs.

In order to understand the effect of nature and distribution of microalloy precipitates on austenite grain structure in reheated condition the above mentioned continuously cast microalloyed steels (one containing Ti and the other containing Nb, Ti and V) have been reheated to different temperatures between 1000°C and 1250°C (1273K and 1523K) and the austenite-grain growth have been investigated. Nature and distribution of microalloy precipitates have been quantitatively analysed before and after reheating. Inhomogeneous distribution of microalloy precipitates, resulted from the interdendritic segregation during casting, can create austenite grain size variation (even grain size bimodality) after reheating. Ti addition reduced the grain size variation, however, could not eliminate the grain size bimodality in Nb-containing steel, due to the differential pinning effect of Nb-precipitates. A model has been proposed for the prediction of austenite grain size variation in reheated steel by combining different models on micro-segregation during solidification, thermodynamic stability and dissolution of microalloy precipitates and austenite grain growth during reheating.

Keywords: Slab reheating, micro-segregation, inhomogeneous precipitate distribution, precipitate stability, austenite grain growth, grain size distribution, precipitation, grain-boundary pinning

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