A Physically based Microstructure Model for Predicting the Microstructural Evolution of a C-Mn Steel during and after Hot Deformation

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A physically based model for predicting microstructural evolution has been developed. The model is based on a physical description of dislocation density evolution, where the generation and recovery of dislocations determine the flow stress and also the driving force for recrystallization. In the model, abnormally growing subgrains are assumed to be nuclei of recrystallized grains and recrystallization starts when the subgrains reach a critical size and configuration. To verify that the model is able to describe dynamic, static and metadynamic recrystallization of C-Mn steels, hot compression tests combined with relaxation were performed at various temperatures, strains and strain rates. The model showed reasonable agreement with the experimental data for the compression tests performed at temperatures ranging from 850°C to 1200°C and strain rates ranging from 0.1 to 10 s^{-1}. Similarly, the calculations of the stress relaxation tests were in accordance with experimental data. A validation of the model was done by calculating a multi-step test where good agreement with both flow-stress values and grain sizes was obtained. The main purpose of the model is to predict the microstructural evolution during hot rolling and this investigation presents very promising results.

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