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DEVELOPMENT OF CELLULAR AUTOMATA MODEL FOR PHASE TRANSFORMATION DURING HEATING OF DP STEEL

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Materials for automobile sector require quick development and improvement to meet increasing customers' demands. The Advanced High Strength Steels (AHSS) are the good representation of modern steel grades with high strength/weight ratio that is required by the automotive industry [1]. The most promising AHSS steels, is the Dual Phase (DP) grade, which is characterized by elevated strength and ductility at the same time. These steels are the subject of intensive research in various laboratories across the world. The experimental investigation is recently more often supported by modern simulation techniques due to limited time and research funds. The Cellular Automata (CA) coupled with Finite Difference (FD) method is an example of modern numerical tool that can be applied to investigate different metallurgical processes and support mentioned experimental analysis. The CA approach is often used to replicate phenomena occurring in real microstructures of various steel grades e.g. recrystallization [2], phase transformation [2] etc. That is why, authors decided to use this method in the present work for simulation of the microstructure evolution during manufacturing of the DP steel.

The manufacturing of DP steel consists of three distinct stages: (1) ferrite recrystallization, (2) ferrite+pearlite-to-austenite phase transformation (heating process) and (3) austenite-to-ferrite+martensite transformation (cooling process). Present research is a continuation of earlier work and focuses mainly on phase transformation during heating. The input microstructure in this case consists of deformed pearlite and equiaxed ferrite grains obtained after ferrite static recrystallization CA simulation (SRX). The model is based on the 2D square grid matrix called CA space, where each cell has a physical dimension of 0.2 μm. Several state variables and internal variables are included in the CA model to comprehend the process of both carbon diffusion and interface mobility. The dissolution of pearlite into austenite, ferrite transformation to austenite and grain enlargement are also taken into account in the present model. The thermodynamics and solute diffusion of the multicomponent system has been calculated using ThermoCalc^{RM} thermodynamic database. The nucleation process is simulated by the classical equation proposed by Roosz *et al.* as a function of overheating [3]. Subsequent growth of

austenite nuclei is controlled by the developed transition rules. The major driving force in this case is carbon concentration. The progress in diffusion of carbon during heating is predicted by the explicit finite difference method. The final microstructure obtained from the model after continuous heating is shown in Figure 1. Comparison of measured and calculated kinetics is presented in figure 2 and show good agreement.

Figure1. Final microstructure obtained after complete phase transformation during heating. Different colours represent different austenite grains.

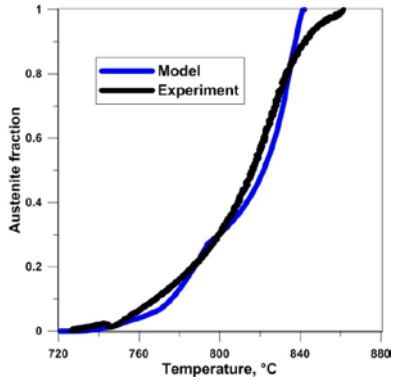

Figure 2. Comparison of kinetics obtained from CA model predictions and experimental analysis for 0.5°c/s heating rate.

The model will be further used to analyse influence of deformation degree on phase transformation kinetics and final grain size obtained during different cooling conditions.

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