3D phase-field simulation of recrystallization in cold rolling and subsequent annealing of pure iron exploiting EBSD data

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ABSTRACT

A material with a microstructure made up of dislocations, subgrains, or grains may lower its energy by the processes of recovery, recrystallization, or grain growth during annealing. A unified theory for continuous and discontinuous annealing phenomena based on the subgrain growth mechanism was proposed by Humphreys[1] about twenty years ago. With the developments in the unified subgrain growth theory, a number of Monte Carlo, vertex and phase-field (PF) simulations have been performed to investigate the nucleation and growth mechanisms of recrystallization by considering the local alignment of the subgrain structure.

In this study, the effects of the microstructural inhomogeneities created in the deformed state on recrystallization kinetics and texture developments were investigated[2]. Numerical simulations of static recrystallization were performed in 3D polycrystalline structures by coupling the unified subgrain growth theory with PF methodology. We applied both the active parameter tracking (APT) algorithm and parallel coding techniques to the multi-phase-field (MPF) model to accelerate computations and to embody large scale calculations. In order to prepare the initial microstructures, 2D electron back scattering diffraction (EBSD) measurements were performed on 90% and 99.8% cold-rolled pure iron. Our previous experimental study has shown that the texture formation processes in the recrystallization of those samples have large difference.

In cold-rolled iron with 90% reduction, simulated texture exhibited nucleation and growth of γ-fiber (ND//<111>) grains by consuming α-fiber (RD//<011>) components, where ND and RD denote normal direction and rolling direction respectively. On the other hand, in cold-rolled iron with 99.8% reduction, simulation results reproduced the high stability of the rolling texture during recrystallization. As a consequence, the simulation results were in good agreements with experimentally observed textures in the both samples.

REFERENCES

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