Three-dimensional Multi-Phase-Field Simulation of Orientation-dependent Ferrite Grain Growth in Steel

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Mechanical properties of steel are strongly affected by its underlying microstructure. In particular, the morphology and distribution of ferrite (α) grain in steel is one of the most essential factor for predicting the mechanical properties of steel. However, since the nucleation and growth behaviors of the α grain during austenite-to-ferrite (γ-α) transformation depends on crystal orientation relationship between γ and α phases, it is difficult to predict the formation of polycrystalline structure of the α grain only by experiments. Therefore, we have developed a GPU-accelerated multi-phase-field (MPF) simulation model for simulating the γ-α transformation and the α grain growth in three-dimensions. However, in our previous study, we assumed isotropic growth of the α grain. In this study, the three-dimensional MPF simulation of the α growth considering the orientation relationship is performed, and effects of the crystal orientation relationship on the morphology and distribution of the α phase are investigated.

Keywords: Multi-Phase-Field Method, Steel, Ferrite Grain Growth, GPU Computing