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Modeling and Simulation for Deformation Twinning in Intragranular Scale Based on Dislocation-Crystal Plasticity and Phase-field Theories

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In HCP metals it is well known that strong anisotropic behavior of dislocation glide for each slip system is shown at room temperature and therefore, deformation twinning becomes an important deformation mechanism to satisfy the strain compatibility. In addition, twinned region is formed in band-like shape in intragranular scale and its crystal orientation has mirror symmetry against that of matrix. This reorientation is not continuous but phase transformation-like phenomenon. In this study, anisotropic behavior of dislocation glide is treated in crystal plasticity framework, on the other hand, formation of twin bands and discontinuous crystal reorientation due to deformation twinning are represented in phase-field framework. These two models are coupled through stress and order parameter. Some numerical simulations are carried out by means of FEM to show a validity of the present model. From results of these simulations, local stress/strain relaxation by formation of twin bands is also investigated.

Keywords: Deformation twinning, HCP metals, Crystal plasticity, Phase-field theory, FEM