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Reproduction Method of Mechanical Anisotropy Induced by Cold Rolling in Crystal Plasticity FE Simulation

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The crystal plasticity FE analysis considering the microscopic information describes the mechanical response of polycrystalline metals at the grain level. When the crystal orientation information of the actual material is applied to the analytical model for the crystal plasticity FE analysis, the crystal orientation is often randomly extracted from the EBSD measurement data. The number of crystal grains in crystal plasticity FE analysis is limited to a small number compared to the actual crystalline metals due to the problem of calculation cost. The conventional method of randomly selecting the crystal orientation does not reproduce the analytical model, and it results in significant variations in the analytical results depending on the combination of crystal orientation. It is essential from the viewpoint of computational cost to reproduce the crystal orientation distribution of the actual material in an analytical model with a small number of grains.

In addition, the rolling texture induced by the rolling process significantly affects the mechanical properties of rolled metals, and mechanical anisotropy caused by the rolling texture appears. Numerical reproduction of the rolling texture of the actual material reproduces the mechanical anisotropy of rolled metals in a crystal plasticity FE analysis.

This study investigates a method to reproduce mechanical anisotropy by accurately reflecting the rolling texture in an analytical model with a small number of grains for crystal plasticity FE analysis. We propose a method to extract the crystal orientation representative of the rolling texture from the crystal orientation measured by EBSD and reflect it in the analytical model. Using the presented method, we perform crystal plasticity FEM analysis. Based on the analysis results, the validity of the proposed model is discussed in comparison with conventional methods.