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Recent advances on crystal plasticity finite element simulation of aluminium alloy under various loading conditions

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A texture-based representative volume element model is developed for the three-dimensional crystal plasticity finite element (CPFE) simulations of polycrystalline aluminium alloys under various loading conditions including nanoindentation, cyclic loading and hot compression. In the simulation, the grain morphology is created using Voronoi tessellation method with the material texture being imported from electron back-scatter diffraction test. In the proposed CPFE model, a back stress is included to simulate the Bauschinger effect during the cyclic loading, while a coupled thermo-mechanical model is implemented in order to simulate the coupled thermal mechanical behaviour involved in the hot compress tests. The model parameters are calibrated using tensile tests performed at 0, 45 and 90 degrees from the rolling direction. The simulation results are validated through the corresponding experiments, suggesting that the proposed CPFE model is capable of capturing the grain level responses of polycrystalline alloys under different loading conditions such as nanoindentation, cyclic loading and high temperature deformation.

Keywords: Crystal plasticity; alloys; nanoindentation; cyclic loading; Bauschinger effect; Coupled thermo-mehcanical.