Simulation of polycrystals during cyclic deformation using crystal plasticity FEM

Juan Luo, Guozheng Kang*

School of Mechanics and Engineering, Southwest Jiaotong University, Chengdu 610031, China

*Correspondent author: Prof. Dr. Kang GZ, E-mail address: guozhengkang@home.swjtu.edu.cn;

Tel: 86-28-87603794; Fax: 86-28-87600797

A crystal plasticity based FEM model is applied in this paper to simulate the cyclic behavior of polycrystalline metals. The Armstrong-Frederick kinematic hardening rule is invoked to capture the Bauschinger effect of the cyclic plastic deformation of the single crystal. A simple model of latent hardening is used to consider the interaction of dislocations within each grain. The constitutive relations are implemented in finite element code. The model is verified by comparing the simulated results of the monotonic tension and ratcheting behavior of a face-centered cubic metal, i.e., rolled 5083 aluminum alloy, with corresponding experimental ones. In the meantime, it is shown that the model is capable of predicting local plastic strain in micro single crystals which plays a role in the ratcheting of polycrystalline aggregate. In addition, the independence of ratcheting strain on the applied stress level and the anisotropy of cyclic deformation are reproduced in this work.

Keywords: Crystal plasticity; Uniaxial ratcheting; Finite element; Face-centered cubic metal