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A grain boundary model considering the grain misorientation within a geometrically nonlinear gradient-extended crystal viscoplasticity theory. (English) Zbl 1472.74032

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Summary: The main goal of the current work is to present a grain boundary model based on the mismatch between adjacent grains in a geometrically nonlinear crystal viscoplasticity framework including the effect of the dislocation density tensor. To this end, the geometrically nonlinear crystal viscoplasticity theory by three of the authors ["A grain boundary model for gradient-extended geometrically nonlinear crystal plasticity: theory and numerics", Int. J. Plast. 118, 17–35 (2019; doi:10.1016/j.ijplas.2019.01.009)] is extended by a more complex free energy and a geometrical transmissibility parameter is used to evaluate the dislocation transmission at the grain boundaries which includes the orientations of slip directions and slip plane normals. Then, the grain boundary strength is evaluated based on the misorientation between neighbouring grains using the transmissibility parameter. In some examples, the effect of mismatch in adjacent grains on the grain boundary strength, the dislocation transmission at the grain boundaries and the Hall-Petch slope is discussed by a comparison of two-dimensional random-oriented polycrystals and textured polycrystals under shear deformation.

MSC:

74C10 Small-strain, rate-dependent theories of plasticity (including theories of viscoplasticity)
74E20 Granularity

Keywords:

grain boundary model; crystal viscoplasticity; small-scale plasticity; misorientation; microsystems; materials science; crystal engineering

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