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Strain Gradient Crystal plasticity Incorporating Grain Boundary Effects

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This paper focuses on a strain gradient enhanced crystal plasticity model that incorporates the intrinsic role of dislocations in their various roles (statistically stored dislocations, geometrically necessary dislocations, grain boundary dislocations) in FCC metals. The crystal plasticity model presented is based on an extended slip law, incorporating a slip resistance and a back-stress, that emerge from the evolution of the three considered types of dislocation densities. The main principles of the underlying framework are outlined and some aspects of the computational solution strategy are emphasized. An example is given that illustrates the non-homogeneous inter- and intragranular deformation in a polycrystalline sample. The explicit incorporation of the grain boundaries and the dislocations accommodating the lattice mismatch of neighbouring grains, is considered as an original contribution. It is shown that the proposed strain gradient crystal plasticity model provides meaningful micromechanical predictions of the associated size or strengthening effects.

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