USING A NONLOCAL CRYSTAL PLASTICITY TO MODEL MATERIAL RESPONSE

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A nonlocal crystal plasticity model is presented. The kinematics, based on the multiplicative decomposition of the deformation gradient, introduces the incompatibility of the intermediate configuration through a dislocation density tensor (gradient term) which represents the presence of geometrically necessary dislocations (GNDs). The thermodynamics of the model identifies this dislocation density tensor as a strain-like quantity describing the lattice curvature, and whose conjugate stress is recognized as the internal stress field associated with a backstress. In addition, the slip system strenght is modified by the presence of the GNDs, leading to a higher rate of strength which reproduces the well known size effect in small grain metals.

The model has been implemented in an implicit finite element framework. This implementation follows a classical ”low order” formulation which is characterized by keeping the conventional boundary value problem (no additional boundary conditions) but the incremental tangent moduli is now a fuction of strain and strain gradients. A number of examples are then solved with this implementation to demonstrate the predictive capabilities of the model.