NONLOCAL PLASTICITY MODEL WITH STRICT ANTI-PLANE SHEAR KINEMATICS: FORMULATION AND VARIATIONAL EQUATIONS

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The formulation and variational equations for a nonlocal anisotropic plasticity model [1,2] with strict anti-plane shear kinematics is presented. These kinematics allow a simpler analysis of the nonlocal plasticity model and its finite element implementation, even though for applications of interest the three-dimensional version will need to be implemented. The nonlocality of the plasticity model stems from the curl of the elastic part of the deformation gradient, requiring a length scale parameter l to yield a dimensionally-consistent deformation measure [1-3]. This curl deformation represents, in an average sense over multiple grains, the elastic lattice curvature that a grain or subgrain cell experiences due to geometrically necessary dislocations at grain or subgrain cell boundaries [4]. This nonlocal plasticity model leads to a partial differential equation, written in variational form for finite element implementation, resulting in coupled governing equations and an additional field (in this case, an internal state variable) for which to solve numerically. We discuss the formulation of the variational equations and application of boundary conditions for the nonlocal internal state variable within the context of strict anti-plane shear kinematics.

References

[1] D.J. Bammann, "A model of crystal plasticity containing a natural length scale," *Mater. Sci. Engng.*, A309–310, 406–410, 2001.

[2] R.A. Regueiro, D.J. Bammann, E.B. Marin, K. Garikipati, "A nonlocal phenomenological anisotropic finite deformation plasticity model accounting for dislocation defects," *J. Eng. Mater. Technol., ASME*, 124(3), 380–387, 2002.

[3] P. Steinmann, "Views on multiplicative elastoplasticity and the continuum theory of dislocations," *Int. J. Eng. Sci.*, 34, 1717–1735, 1996.

[4] D.A. Hughes, Q. Liu, D.C. Chrzan, N. Hansen, "Scaling of microstructural parameters: misorientations of deformation induced boundaries," *Acta mater.*, 45, 105–112, 1997.