Efficient Numerical Implementation of Length-Scale Dependent Polycrystal Plasticity Theories

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ABSTRACT

We present the numerical implementation of non-local polycrystal plasticity theories using an elasto-viscoplastic (EVP) Fast Fourier Transform (FFT)-based formulation [1]. Numerical procedures for the accurate estimation of higher-order derivatives of micromechanical fields are identified and applied to calculate Geometrically-Necessary Dislocations (GND) density fields [2]. The separate and combined effects of GNDs on energetic and dissipative hardening are studied. The new formulation is first used to solve a periodic laminate made of two crystals to assess the soundness and stability of the proposed algorithms, and next applied to 3-D fcc polycrystals, illustrating the computation of meaningful non-local polycrystal plasticity solutions of large problems in reasonable times. Moreover, the presence of porosity and its evolution in a polycrystalline matrix [3] is combined with the aforementioned non-local plasticity theories.

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