VISCOPLASTIC MODELS FOR FERROELECTRIC CERAMICS

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Abstract

Nonlinear hysteretic phenomena in polycrystalline ferroelectric ceramics are simulated using viscoplastic (rate-dependent) models without a switching condition. Viscoplastic models describe the domain structure evolution effectively: in terms of rate equations for the volume fractions of orientation variants. The results of a comparative study of two viscoplastic models for polycrystalline ferroelectrics undergoing a cubic-to-tetragonal phase transition are discussed. Both models allow for 90° and 180° polarization switching, but differ in the number of accessible domain orientations, which is six and forty-two, respectively. While the model with six polarization orientations provides a reasonable description of ferroelectric ceramics under uni-axial loading, the model with forty-two orientations reproduces the typical isotropic behaviour of polycrystalline materials and can be parameterized for multi-axial loading. Examples of the viscoplastic models application to rate-dependent phenomena in soft PZT ceramics and to a 3D finite element analysis of microstructural inhomogeneities in ferroelectric multi-layer films are given.

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