The influence of crack face electrical boundary conditions on the nonlinear behavior of ferroelectric single crystal

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The nonlinear electromechanical behaviors of a cracked ferroelectric single crystal subjected to pure electrical loadings are investigated with different crack face electrical boundary conditions by a three-dimensional phase field model. Phase field simulations show that the crack face electrical boundary condition has significant influence on the electrical and mechanical responses of the ferroelectric single crystal to an external electric field. The coercive field for the polarization switching of the single crystal with an electrically permeable crack is about 50% larger than that of the single crystal with an electrically impermeable crack. The remanent strain and the strain variation induced by polarization switching in the single crystal with the permeable crack are larger than those with the impermeable crack. The different macroscopic nonlinear behaviors are attributed to the different polarization switching processes. It is found that the domain switching takes place from the surface of the single crystal with a permeable crack, while it begins from the vicinity of the crack tip when the crack is impermeable. The ferroelectric single crystal with the impermeable crack exhibits strip 90^o domain switching under the negative electric field, which is consistent with the experimental observation.

Keywords: Ferroelectrics; Crack face boundary condition; Domain switching; Electromechanical response