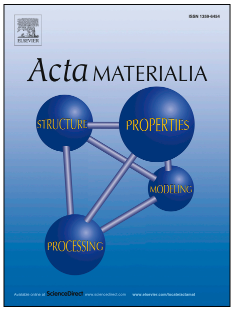

Defect-mediated vortex multiplication and annihilation in ferroelectrics and the feasibility of vortex switching by stress

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Defect-mediated vortex multiplication and annihilation in ferroelectrics and the feasibility of vortex switching by stress

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Abstract

The possibility of switching the direction of the dipole toroidal moment in ferroelectrics provides exciting opportunities for development of novel nanoscale memory and logic devices. However, a practical control of vortex chirality is rather challenging at present stage, not to mention via mechanical methods. In this paper, we performed the phase-field simulations to show that mechanical switching of vortex chirality can be achieved in ferroelectric nanoplatelet via defect engineering. After introducing a void defect in the nanoplatelet, relative stability of single-vortex state and multi-vortices state is found to be altered. Importantly, during stress-induced vortex multiplication process, the void is a favored nucleation core of new vortex; meanwhile, vortices tend to annihilate away from the void during a vortex annihilation process. As the favored regions of vortex nucleation and annihilation are not the same, a deterministic mechanical switching of vortex chirality can be achieved. The effects of temperature, shape of the nanoplatelet, void size, as well as void position, on the defect-mediated vortex switching behaviors are systematically revealed. Our study demonstrates the feasibility of vortex switching by mechanical loads and provides a route to control and develop electromechanical devices based on ferroic vortices.

Keywords: Ferroelectrics; Vortex; Mechanical switching; Defect engineering

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