Purely electric-field-driven perpendicular magnetization reversal

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Magnetization reversal purely with an electric field, if achieved, has the potential to revolutionize the spintronic devices that currently utilize power-dissipating currents. However, all existing proposals involve the use of a magnetic field. Here we use phase-field simulations to study the piezoelectric and magnetoelectric responses in a three-dimensional multiferroic nanostructure consisting of a perpendicularly magnetized nanomagnet with an in-plane long axis and a juxtaposed ferroelectric nanoisland. We demonstrate, for the first time, a full reversal of perpendicular magnetization via successive precession and damping, driven purely by a perpendicular electric-field pulse of certain pulse duration across the nanoferorroelectric. We discuss the materials selection and size dependence of both nanoferroelctrics and nanomagnets for experimental verification. These results offer new inspiration to the design of spintronic devices that simultaneously possess high density, high thermal stability, and high reliability.

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