Electric-Field Control of Magnetism in Strain-Coupled Ferromagnetic-Ferroelectric Heterostructures

Sebastiaan van Dijken

NanoSpin, Department of Applied Physics, Aalto University School of Science, P.O. Box 15100, FI-00076 Aalto, Finland

Spintronic devices currently rely on magnetic switching or controlled motion of magnetic domain walls by an external magnetic field or spin-polarized current. Achieving the same degree of magnetic controllability using an electric field has potential advantages including low power consumption. Here, an approach to electrically control local magnetic properties will be discussed [1-5]. The method is based on recurrent strain transfer from regular ferroelastic stripe domains in a ferroelectric $BaTiO_3$ substrate to magnetostrictive films (e.g. CoFe, CoFeB, and Fe). Dominance of the strain-induced magnetoelastic anisotropy in these heterostructures causes full imprinting of ferroelectric domain patterns into ferromagnetic films and strong pinning of magnetic domain walls onto ferroelectric boundaries. Optical polarization microscopy measurements of the ferromagnetic and ferroelectric domain structures indicate that domain correlations and strong inter-ferroic domain wall pinning are maintained in an applied electric field. As a result, deterministic electric-field control over the formation and erasure of ferromagnetic domains and reversible motion of magnetic domain walls is obtained, opening up new routes towards electric-field driven spintronics.

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