Gradient magnetoelasticity: tailoring of antiferromagnetic textures

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Nowadays antiferromagnets are considered as important constituents of the spintronic devices. They show fast magnetic dynamics and can be effectively manipulated by the electric current or laser pulses. Many of technologically attractable antiferromagnets also show strong magnetoelastic effects, which can prevail over the direct spin-torque mechanism and can be used for control and manipulation of the devices. However, an important prerequisite of such thermomagnetoelastic effects is inhomogeneous distribution of strains. In this presentation we discuss the effects associated with the strain gradients that appear in antiferromagnetic devices due to the clamping by nonmagnetic substrate, patterning, or current/temperature gradients. We introduce the concept of magnetoelastic charges that are associated with the magnetic inhomogeneities and with incompatibility (break of continuity) of the related spontaneous strains. Such magnetoelastic charges produce a long-range strain field, which, similar to magnetostatic stray field in ferromagnets, controls distribution of antiferromagnetic domains and orientation of the domain walls, and modifies local magnetic anisotropy. Inspired by the gradient elasticity approach we generalize it to include magnetoelastic effects and apply it to interpretation of the observed magnetic textures in different antiferromagnets relevant for spintronic applications. Our findings open new ways to manipulate antiferromagnetic textures by proper tailoring of the magnetic and magnetoelastic gradients.