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DOMAIN WALLS IN MAGNETO-ELASTIC HETEROSTRUCTURES: MODELING AND EXPERIMENT

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Domain walls, skyrmions and other nanoscale spin structures are considered as key elements of future 3D nanodevices of information processing, including nonvolatile memory devices [1]. Interest in such structures is also due to the phenomenon of new physical effects associated with nanosize, topology and chirality of magnetic elements. In turn, magnetic nanostructures with controlled magnetoelastic properties are promising for creating information storage and processing devices with record energy consumption [2-4], up to tens of attojoules per one elementary operation to change the state of nanoelement's magnetization.

The possibility to manipulate domain walls in magnetoelastic nanostripes by means of uniform mechanical stresses has been numerically demonstrated [5]. Elastic stresses induced by the piezoelectric layer are used to change the magnetic state of the nanostripe (Fig., and.) In this case, the domain-wall velocity of the same order of magnitude as when exposed to magnetic fields or spin-polarized currents is achieved, and energy consumption is significantly reduced.

This paper presents the results of modeling and experimental study of the domain structure and magnetization reversal processes of magneto-elastic parabolic-shaped nanostripes (Fig., b-d). Multilayered magnetostrictive films of TbCo₂/FeCo composition were deposited onto piezoelectric PMN-PT substrates by RF sputtering using a Leybold Z550 equipment [6]. The deposition was made under a magnetic field generated by permanent magnets in order to induce a magnetic easy axis anisotropy in the desired direction in the plane of the multilayer film. Then, micro- and nanostructures of various shapes were formed in the films by lithography for experimental study of magnetization distribution, processes of magnetization reversal, formation and movement of domain walls in the films.

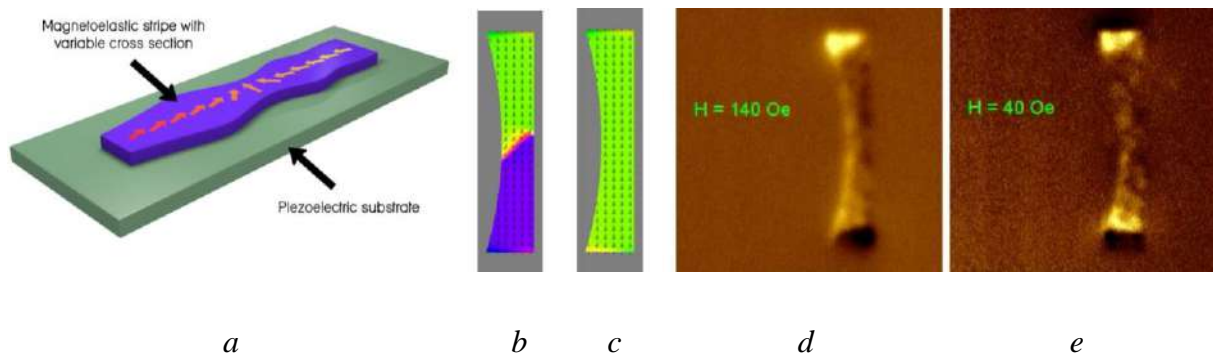


Fig. Model (*a-c*) and image (*d-e*, magnetic force microscopy) of the domain structure in magnetoelastic nanostructures of variable width.

It is shown that in the initial state in the nanostructure, depending on the prehistory of the magnetization/demagnetization of the nanostructure, there are two variants for the formation of an equilibrium magnetic structure – with asymmetric (Fig. *b, d*) or symmetrical (Fig. *b, e*) direction of the magnetization vectors at the edges of the nanostructure and, accordingly, with a state close to the monodomain, or split of the parabolic-shaped nanostructure into domains. The symmetry breaking of the stable magnetization states in the nanostructure can be realized by a static magnetic field applied perpendicular to the easy axis of the ferromagnetic. Further change of magnetization states allows their manipulation by means of homogeneous mechanical effects induced by the application of an electric field to the piezoelectric substrate.

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