

Different Aspects Determining Magnetization Reversal in Patterned Ferrimagnetic Multilayers

M. Matczak,¹ F. Stobiecki,¹ D. Kiphart,¹ and P. Kuswik¹

¹*Institute of Molecular Physics, Polish Academy of Sciences
Mariana Smoluchowskiego 17, 60-179 Poznań, Poland*

The magnetization reversal of ferromagnetic layered systems and its nanostructures, induced by an external magnetic field, has been extensively described in the literature [1]. Considerably less attention has been devoted to this process in ferrimagnetic nanostructures [2–4]. We investigated sputtered Co/Tb multilayers (MLs). In the as-deposited state, these MLs are characterized by perpendicular anisotropy and domination of the Tb sublattice (Tb+). Magnetic patterning was achieved by bombardment with 10 keV He+ ions through a resist mask [2,3]. The ion doses (D) were chosen to induce domination of the Co sublattice (Co+), forming a two-dimensional lattice of squares. The non-irradiated matrix (D=0) remained Tb+. Two different ion doses, D* and D** (D>D**), were applied so that the switching fields (HS) of the squares (H_S^S) and the matrix (H_S^M) satisfied the relations $H_S^S < H_S^M$ for D=D* and $H_S^S > H_S^M$ for D=D**, respectively. In addition to magnetic patterning, topographic patterning of Co/Tb MLs was performed, resulting in networks of magnetically isolated squares of various sizes. Hysteresis loop measurements, combined with domain structure observations, demonstrate that two-dimensional lattices of squares obtained by ion bombardment exhibit a two-stage magnetization reversal process, in which the matrix and the squares reverse magnetization independently. In a saturating magnetic field, the system is in a single-domain state, with domain walls (DWs) formed at the boundary between the squares and the matrix. After magnetization reversal of the squares (matrix), a multidomain state without DWs is formed in samples irradiated by ions with D* (D**) [2,3]. Minor hysteresis loop measurements indicate that the HS for the transition from the single domain to the multidomain state is significantly smaller than that for the reverse transition. A distinct distribution of nucleation fields was observed for topographically patterned lattices of squares. As a consequence, an increase of HS was observed, similar to that reported for ferromagnetic layers [1]. Therefore, the asymmetry of minor hysteresis loops observed for magnetically patterned lattices strongly suggests that the presence of DWs in the single domain state also plays an important role as nucleation centers for the transition from single domain to the multidomain state, reducing the magnetic field related to this transition. This effect is independent of and complementary to our previous statement related to the crucial role of the distinctly smaller energy of the multidomain state [2,3].

References:

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