Tunable magnetic properties in ultrathin Co films on vicinal substrates

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The ultrathin magnetic materials with strong perpendicular anisotropy are the object of intensive investigations due to applications in magnetic storage media. The vicinal substrates are often used as templates for the growth of magnetic self-organized nanostructures [1] and also for tailoring spin-reorientation transition, from perpendicular to in-plane magnetization orientation [2], since the step contribution to the magnetic anisotropy of the spin-orbit interaction can be comparable with the surface one [3].

We report on anisotropic dynamics of magnetic domain walls in ultrathin Au/Co/Au films grown on vicinal Si(111) substrates with different surface morphology (either single steps or bunches). The samples have been prepared by molecular beam epitaxy in an ultra-high vacuum system. The magnetic domain structure and domain wall velocity were investigated at room temperature by optical polarizing microscope using the magneto-optical Kerr effect. The experiments reveal a strong increase of the velocity ratio between the two in-plane directions for samples with higher step-density. In particular, the velocity of domain walls is increased by 2 orders of magnitude for Co films on bunched Si substrate [4]. We develop an analytical model revealing the modified at the steps exchange interactions as a main driving force for this anisotropic behavior. For the sake of qualitative description of the domain wall propagation in ultrathin Co magnetic films on vicinal substrates the micromagnetic simulations have been performed.

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