Magnetic ordering in ultrathin Co films grown on vicinal substrates

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A review of magnetic and magnetooptical properties of ultrathin cobalt films grown on vicinal surfaces is given. In the present work we report on magnetic reversal, magnetic anisotropy, and domain structures in ultrathin Co films grown by molecular beam epitaxy on vicinal sapphire substrates in the wide Co thickness range. The following nanostructures were deposited on sapphire single-crystal (11-20) wafers with miscut angle from 1 to 5 degrees: (i) first buffer layer of 20 nm Mo(110) deposited at T=1000°C, (ii) second buffer layer of 10 nm Au(111) deposited at room temperature and annealed at T=200°C, (ii) Co flat layers or Co wedges with thickness range 0 - 2.3 nm, (iii) 8 nm thick Au cover layer. The structure of the samples was monitored in-situ by RHEED. Measurements were performed at room temperature using magneto-optical Kerr effect (MOKE) based magnetometer, polarizing Kerr microscope in the polar configuration and FMR X-band spectrometer. Magnetization processes were studied in both longitudinal and polar MOKE experiments. Changes of in-plane magnetic anisotropy symmetry were deduced from shape analysis of the magnetization curves and angular dependence of the resonance field measured in the sample plane. Two-fold and fourfold symmetry were observed for different miscut angles. Changes in domain structure were observed in a wide Co thickness range. The evolution of the domain structures during the magnetization reversal processes was studied. Preferential orientation of domain walls was observed. In the area of the domain wall propagation the stripe-shaped domains with preferential orientation of domain walls were observed. The preferential direction of domain walls and the coercivity field depend on both Co thickness and the miscut angle. The preference of the domain wall propagation is explained by the competition of different mechanisms of magnetic anisotropy changes. The experimental data, will be discussed taking into account the following energy contributions: (i) demagnetization term, (ii) surface and bulk uniaxial anisotropy, (iii) and step-induced uniaxial anisotropy. Magnetic anisotropy constants are fitted for different miscut angles. In the framework of the proposed model of magnetic anisotropy, the micromagnetic simulations for description the processes of reversal of magnetization ultrathin Co magnetic films on vicinal substrates, were performed.

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