Magnetocrystalline effects in narrow ferromagnetic patterns

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We introduce a reduced micromagnetic framework for the study of narrow ferromagnetic patterns on thin films with cubic magneto-crystalline anisotropy. The relevant patterns are curves of arbitrary shape that could be described as "curves with a width", such as annuli and magnetic tracks. In these geometries, the magnetization is constant in the directions perpendicular to the curve and changes smoothly in the longitudinal direction. The curve makes an angle α with the easy axis and the magnetization is described by its tilt from the easy axis, θ. We define a parameter Δ that measures the ratio of crystalline to shape anisotropy energies and study the existence of stable configurations (energy minimizers) as Δ varies. For $\Delta<0.5$ the magnetization is closely aligned along the longitudinal direction and only π domain walls produce discontinuities in θ. These π walls are charged and interact magnetostatically. For $0.5<\Delta$ there are charge-free domain walls whenever α makes a $\pi/4$ angle with the easy axis. We apply this framework on nanorings and find the global energy minimizers in the presence on non-negligible anisotropy.