Micromagnetic investigation of domain wall morphology in perpendicular anisotropy microwires with anisotropy gradient and structural defects

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A reliable control of field or current driven dynamics of domain walls (DWs) in various magnetic conduits is crucial for prospective applications in senor, memory or logic devices [1]. Depending on technology involved the control may be realized, among others, by geometric constraints [1] or introduction of structural defects [2]. In the latter case an ion bombardment may be used to induce changes within a material that ultimately alter an effective anisotropy of the system and influence DW response to the field. The defects, in otherwise magnetically relatively homogeneous layers, locally change DW nucleation field and significantly affect their motion [2]. In this contribution we show micromagnetic analysis, using OOMMF software, of the DW propagation in $1\,\mathrm{nm}\times 4\times 1\,\mu m^2$ strips with a constant perpendicular magnetic anisotropy (PMA) gradient along their longer edges and randomly distributed defects of two kinds. The defects are either micromagnetic cells with zero magnetization or cells with PMA reduced by $3\,\%$ relative to the gradient background. The changes of the DW shape as it propagates along the strip are analyzed using image analysis, as a function of the number of both types of imperfections. Preliminary results show that if roughly $3\,\%$ of the cells have no magnetic moment convexity of the DW, defined as a ratio of its length to the distance between its terminals, approaches one, as opposed to the case with no defects. The anisotropy defects which locally decrease the PMA below the minimum value of the defect-free simulation lead to significant random contribution to the domain nucleation and in effect render the walls increasingly convex.

References:

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