Numerical prediction of the functionality window for a stripe cross (an intersection) as a key element in magnetic logic devices and multiturn sensors

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To realize modern magnetic devices using moving magnetic domain walls (DWs) as the key entities, intersections of magnetic stripes are mandatory for the technological realization in a 2D geometry. This holds for the concept of a magnetic logic [1] and for turn sensors with storage capability (multi-turn counter) [2] able to count to 10^4 to 10^6 turns [3].

In this talk, we present the study of the DW dynamics in GMR stripe structures, with the focus on the process of passing the intersections in such systems. This process is the main bottleneck in the development of the above-mentioned devices due to the risk that the domain wall can bend into a wrong stack branch, leading to its magnetization reversal (Fig.1b); in this case the resulting magnetization state would prevent the normal device functioning. A further difficulty is that stripe intersections always lead to a relatively strong pinning of a domain wall (Fig.1c). Our aim is to predict the working field range for such a design, where a DW passes through the stripe intersections (Fig. 1d) and to optimize the stripe geometry for the reliable work of magnetic-field-based sensors. The passage of a DW through the above-mentioned crossings is simulated in dependence on various factors (stripe geometry, external field angle and magnitude). The influence of the magnetodipolar interaction between different layers of the GMR stack is also taken into account. In addition, the influence of the non-ideal geometry of the intersection, which is reflected in a certain "rounding" of the intersection between the perpendicular stripes, is also considered.

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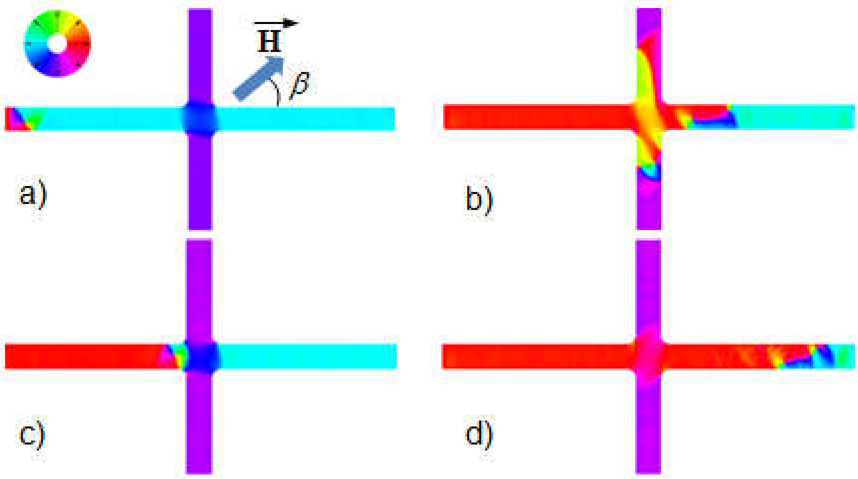

Figure 1. The initial magnetization state of the thin-film stripe intersection (a) and three possible magnetization states (b, c, d) after the domain wall crossing.

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