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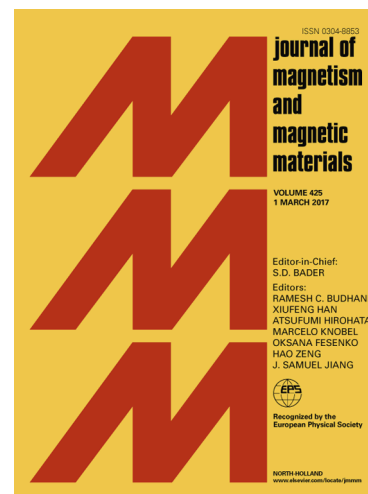
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Robustness of majority gates based on nanomagnet logic

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Abstract

We studied the evolution of the magnetic state of a majority logic gate consisting of a cluster of five dipolarly-coupled nanomagnets, fabricated by e-beam lithography, under the application of a clocking field, using a combination of magneto-optical Kerr effect and magnetic force microscopy. The data were interpreted by advanced GPU-based micromagnetic simulations, where, in addition to the single ideal-shaped gate, a 3x3 array of “realistic gates”, whose shape is directly derived from scanning electron microscopy images, is considered. A fairly good agreement between measurements and simulations has been achieved, showing that asynchronous switching of nominally identical gates may occur, because of unavoidable structural and morphological imperfections. Moreover, a slight misalignment of 1°-2° of the clocking field with respect to the hard axis of the dots may be detrimental for the correct logic operation of the gates. It follows that reliable, error-free and reproducible operations in future magnetologic devices would require tight control and precision of both the lithographic process and the direction of the clocking field. Moreover, a significant improvement could be insured by a stronger dipolar coupling between the dots, for instance increasing their thickness and/or using materials with larger magnetization.

Keywords

Nanomagnet logic; Magneto-optical Kerr effect; Magnetic force microscopy; Micromagnetism

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