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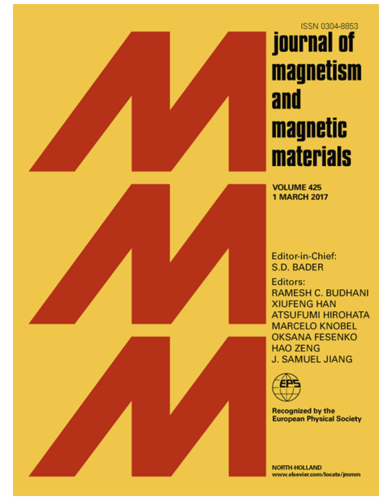

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Robustness of majority gates based on nanomagnet logic

Marco Gonelli[1], Samuele Fin[1], Giovanni Carlotti[2], Himadri Dey[3], György Csaba[3,4], Wolfgang Porod[3], Gary H. Bernstein[3], and Diego Bisero[1]

[1]*Department of Physics and Earth Sciences, University of Ferrara, Italy*
[2]*Department of Physics and Geology, University of Perugia, Italy*
[3]*Center for Nano Science and Technology University of Notre Dame, IN, USA*
[4]*Faculty of Information Technology and Bionics, Pázmány Péter Catholic University Budapest, Hungary*

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; Magnetooptical Kerr effect; Magnetic force microscopy; Micromagnetism