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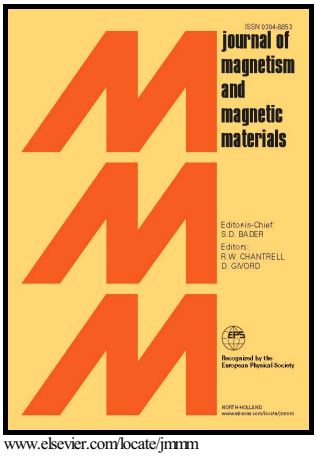

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Stabilization mechanisms for information stored in magnetic nanowire arrays

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Abstract

The durability of the stored information in magnetic systems is one important feature in firmware applications such as security codes, magnetic keys and other similar products. In the present paper we discuss two different ways of preserving patterns in the set of magnetic wires trapped in the porous membranes used to produce them. One of the techniques is the inscription of an opposite magnetic band of about 1/3 the width of the stored pattern which minimizes the repulsive energy among the ferromagnetic cylinders still leaving a potent magnetic signal to be read. The other technique makes use of segmented nanowires which present a competition of repulsive energy of segments within the same layer while the interaction is attractive with the closer segments of the other layer; such a competition can lead to stabilization if the geometrical parameters are properly controlled. The first technique is cheaper and faster to implement, while the second technique needs a more complete fabrication process but can lead to more durable stored information.

Keywords: Nanowires, nanoelectronic devices, magnetic recording, firmware

1. Introduction

Magnetic nanowires trapped in the porous membrane used to produce them [1, 2, 3, 4, 5, 6] can be used to store information in the form of ferromagnetic patterns inscribed over such set of nanopillars [7, 8]. However, magnetic orientation of single magnets is subject to reversal effects[3, 9, 10, 11], which is more noticeable in small systems. This is an aging phenomenon which could gradually fade away the stored information. Two mechanisms have been recently proposed to stabilize the system with respect to spontaneous reversals: by inscribing an opposite ferromagnetic band (OFB), and by employing multisegmented magnetic wires [12], which have also been syntetized experimentally [13, 14]. In this paper we analyze advantages and disadvantages of these stabilization mechanisms by calculating interaction energies for a variety of symbols having different symmetries.

The prevalence of the stored information in the form of parallel magnetization of patterns within the system will be improved upon minimizing the repulsive energy among the magnets within the ferromagnetic sectors. One simple way to approach this problem is to inscribe a ferromagnetic band with the magnetic field in opposition to the main pattern, namely, an OFB. For some basic geometrical shapes it has been shown [8] that such OFB needs to be only about 1/3 of the original pattern to minimize the repulsive energy, still providing a net ferromagnetic signal with the shape of the stored pattern. However, the overall signal will be somewhat weak needing a close approach of the reader mechanism to obtain the information.

A different way to minimize the repulsive energy is to make use of segmented nanowires, where the segments tend to form layers of cylinders. Let us consider a particular segment (pivot) in any layer. The pivot interacts attractively (negative energy) with those segments of the neighboring layers included within a cone defined by the geometrical conditions of the system [12, 15]. Outside this cone which also includes all the segments in the same layer of the pivot the interaction is repulsive (positive energy). This competition between negative and positive components can be optimized for each system upon varying the geometrical parameters, where the separations between consecutive layers plays a key role. Then, a stable structure can be reached so to produce durable patterns with potent magnetic signal. A possible disadvantage of this method of preserving informa-

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