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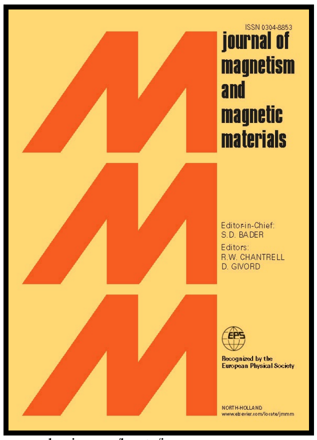

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Magnetic vortex racetrack memory

Liwei D. Geng, Yongmei M. Jin*
Materials Science and Engineering Department, Michigan Technological University, Houghton, MI 49931, USA

*ymjin@mtu.edu

Abstract
We report a new type of racetrack memory based on current-controlled movement of magnetic vortices in magnetic nanowires with rectangular cross-section and weak perpendicular anisotropy. Data are stored through the core polarity of vortices and each vortex carries a data bit. Besides high density, non-volatility, fast data access, and low power as offered by domain wall racetrack memory, magnetic vortex racetrack memory has additional advantages of no need for constrictions to define data bits, changeable information density, adjustable current magnitude for data propagation, and versatile means of ultrafast vortex core switching. By using micromagnetic simulations, current-controlled motion of magnetic vortices in cobalt nanowire is demonstrated for racetrack memory applications.

Keywords: magnetic vortex, magnetic nanowire, micromagnetic simulation, magnetic racetrack memory

1. Introduction

Recent development of magnetic domain wall racetrack memory (DWRM) has received attention as an emerging non-volatile memory technology, promising high density, fast data access, and low power [1]. DWRM is based on current-controlled movement of domain walls in magnetic nanowires of in-plane [1, 2] or perpendicular [3,4] anisotropy, where data are stored through the magnetization direction of magnetic domains in the nanowire. In DWRM, regularly spaced constrictions (or pinning sites) are fabricated along the racetrack to define the bit length and pin domain walls, and short current pulses are used to shift domain walls for data propagation. This paper presents a new racetrack memory, i.e., magnetic vortex racetrack memory (MVRM), using micromagnetic simulations. MVRM is based on current-controlled movement of magnetic vortices in magnetic nanowires of weak perpendicular anisotropy. In MVRM, data are stored through the vortex core polarity, and a series of data bits are encoded in an array of vortices in the nanowire. Unlike DWRM where the data bits are defined by the constrictions built in the nanowire, the data bits in MVRM are individual vortices that actually move in the nanowire under controlling current. This distinct feature of MVRM using mobile magnetic vortices as individual data carriers grants additional advantages over DWRM. In MVRM, since one vortex defines one data bit, there is no need for the regularly spaced constrictions along the racetrack, the information density (or the number of data bits) in a given racetrack can be varied by simply changing the number of magnetic vortices, and the magnitude of spin-polarized current for data propagation can be adjusted through vortex pile-up effect as will be explained. Moreover, MVRM can benefit from the ultrafast switching of magnetic vortex