Memory Bit Selection and Recording by Tailored Pulse Fields in Vortex-core Cross-point Architecture

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Energy-efficient, ultrahigh-density, ultrafast,and nonvolatile solid-state universal memory has been a long-held dream in the field of information storage technology. Magnetic vortices in micrometer-size (or smaller)magnetic dots are one of the most promising candidates for practical storage device applications[1], not only because of the energetically stable twofold ground states of their core magnetizations but also due to the easily controllable, low-power-consumption core switching through resonant vortex-core excitation[2-4].

Here we propose a robust information storage, recording and readoutmechanism based on the twofold ground states of vortex-core magnetizations and the novel gyration and switching dynamics, which can be implemented in nonvolatile magnetic random-access memories. We are going to present low-power-consumption vortex-core switching in magnetic nanodisks using tailored pulse fields produced with orthogonal and unipolar Gaussian-pulse currents. The optimal width of the orthogonal pulses and their time delay are found, from analytical and micromagnetic numerical calculations, to be determined only by the angular eigenfrequency ω_D for a given vortex-state disk of polarization p, such that $\sigma = 1/\omega_D$ and $\Delta t = \frac{\pi}{2} p/\omega_D$ [5]. The estimated optimal pulse parameters are in good agreement with the experimental results. We also experimentally demonstrate reliable memory-bit selection and information recording in vortex-core cross-point architecture, specifically using a two-by-two vortex-state disk array[6]. In order to efficiently switch a vortex core positioned at the intersection of two orthogonal electrodes, only the corresponding two crossed electrodes are selected, and then Gaussian pulse currents of optimal pulse width and time delay are applied. Such tailored pulse-type rotating magnetic fields which occurs only at the selected intersection is prerequisite for a reliable memory-bit selection and low-power-consumption recording and readout of information in the existing cross-point architecture.This work lays a foundation for energy-efficient information recording in vortex-core cross-point architecture. This work was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (No. 20110000441).

References

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