Nonvolatile Vortex Random Access Memory

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An energy-efficient, ultrahigh-density, ultrafast, and nonvolatile solid-state universal memory is a long-held dream in the field of information-storage technology [1]. The magnetic random access memory (MRAM) [2] along with an alternative spin-transfer-torque switching mechanism [3,4] becomes a strong candidate for such a memory, owing to its nonvolatility, infinite endurance, and fast random access. The magnetic vortex having the fourfold ground state in patterned soft magnetic dots promises ground-breaking applications in information-storage devices, owing to its very stable twofold ground state of either their upward or downward core magnetization orientation [5,6] and plausible core switching by in-plane alternating magnetic fields [7] or spin-polarized currents [8]. However, low-power recording and reliable selection of each memory cell with already existing cross-point architectures have not yet been resolved for the basic operations in information storage, that is, writing (recording) and readout [9].

In this talk, we report on an experimental demonstration of magnetic vortex random access memory (VRAM) based on the cross-point architecture scheme. Reliable cell selection and low-power-consumption control of switching of out-of-plane core magnetizations have been realized using specially designed rotating magnetic fields generated by two orthogonal and unipolar Gaussian-pulse currents along with optimized pulse width and time delay. These storage and recording operations based on a medium composed of patterned vortex-state disks, together with the novel phenomenon of ultrafast vortex-core switching can stimulate further fruitful research on MRAMs that are based on vortex-state dot arrays.

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