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Vortex and Spin Dynamics in Nanoscale Magnetic Elements

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The ultrafast magnetization dynamics in patterned elements has attracted a great deal of recent attention due to its possible applications in high-density magnetic data storage devices. In particular, the vortex structures and their behaviors have been intensively studied to explore their possible application as magnetic bits [1-4]. In our recent micromagnetic modeling it has been demonstrated that the vortex core magnetization can be switched by applying a short (<100 ps) magnetic field pulse [2]. This is an important step towards utilizing the two stable states of the core magnetization in memory device elements. For practical applications, however, it is not practical to control the magnetization state by applying a magnetic field. Therefore, the current-driven manipulation of the magnetization was proposed, in which electric current is polarized by aligning the spin direction of the electrons flowing through a magnetic thin film. Very recently, we reported detailed numerical studies of the spin-torque effect on the magnetization in a multilayered (NiFe/Cu/Co) nanostructure, in which the magnetic vortex chirality of NiFe can be controllably switched by injecting a current pulse with appropriate amplitude, polarity, and duration [4]. From an application point of view, this discovery leads to a new way to reverse magnetization of memory element. Due to these advantages, spin-polarized current-driven control of the vortex chirality in nanopillar is highly attractive for potential applications in future non-volatile magnetic memory, provided that the switching of vortex chirality can take place as fast as a magnetic field-induced switching. In this paper, we will present our recent results of vortex behaviors and spin dynamics appeared in Pac-man shaped NiFe/Cu/Co nanostructure and NiFe/Cu/Co nanopillar and also lateral size effect on magnetization ringing in Pac-man shaped NiFe elements.

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BD02

Influence of 3d-metal Doping on Magnetotransport Properties of Magnetite Thin Films

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Variation in magnetoresistance (MR) by transition-metal (TM) doping in magnetite (Fe_3O_4) has been investigated. The samples ($T_xFe_{3-x}O_4$, T = V and Cr) were polycrystalline and prepared as thin films by a sol-gel method. As the TM composition (x) increases, the MR strength is reduced but the reduction rate with x differs significantly for the two TM-doping cases. For the V-substituted samples the MR is reduced rapidly with x and no significant MR is detected above x = 0.11. On the other hand, the Cr-substituted samples exhibit the MR effect up to x = 0.49. Such difference in MR strength between the two TM-doping cases is attributable to the difference in the intrinsic properties of the ternary ferrites such as electronic structure and carrier spin polarization.