Effect of magnetostatic field on magnetic field-driven vortex dynamics : vertically coupled vortices

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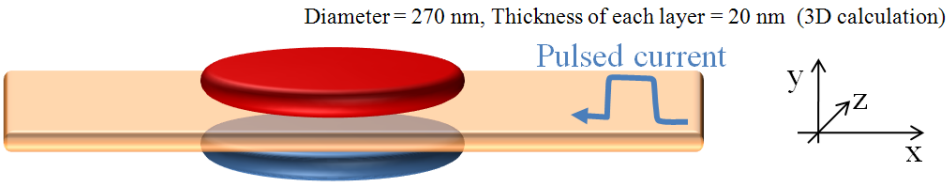
A vortex is a stable magnetic state for a patterned disk. It has both in-plane curling magnetization (chirality) and out-of-plane magnetization at the center of disk (core) because of competition between magnetostatic and exchange energy. Thus, 4 different states can exist as a ground state depending on chirality (clockwise (CW) or counter-clockwise(CCW)) and polarity (+ or -); (CW,+), (CW,-), (CCW,+) and (CCW,-). Because of these bi-stable properties of vortex state, it is proposed for potential non-volatile memory called vortex-based random access memory using its polarity as information carrier.[1,2]

Thus, vortex-based spin-valve[3] and array of vortices[4,5] has been intensively studied both analytically and experimentally. Recently, it is reported that vortex can propagate the signal with low energy dissipation through dipolar interaction and it points out the importance of dipolar interaction between vortices[6].

By means of micromagnetic simulation, we examined the effect of magnetostatic field on dynamics of coupled vortices. In order to study the effect of dipolar interaction on vertically-coupled vortices numerically, we performed micromagnetic simulation using Landau-Lifshitz-Gilbert equation. Nanodisks, which have the 20 nm of thickness and the 270 nm of diameter, are separated by an empty space (20 nm) is assumed as shown in Fig. 1. Fig. 2 (Fig. 3) shows the change in the velocity (position) of core obtained from 4 different configurations. And in-phase and out-of-phase motion are observed depending on configuration of layers. More detailed dynamics with carious magnetic configuration of layers will be discussed in detail.



Magnetic configuration of top and bottom layer

	(CW,+)	(CW,-)	(CCW,+)	(CCW,-)
	(CW,+)	(CW,+)	(CW,+)	(CW,+)

Fig.1 Schematic illustration of modeling system

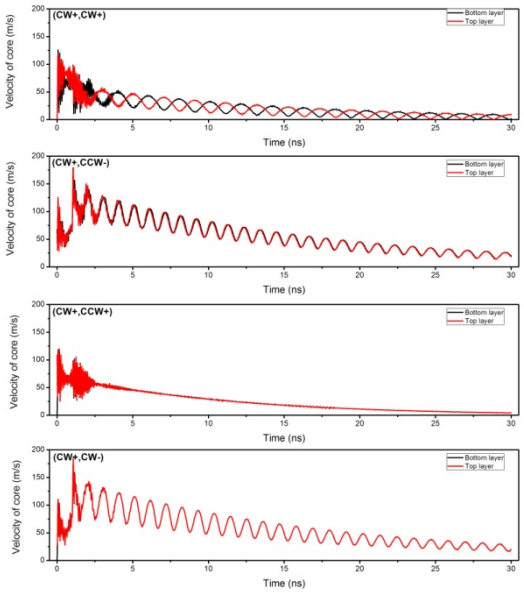


Fig. 2 The velocity of a vortex core for 30 ns depending on 4 different magnetic configurations.

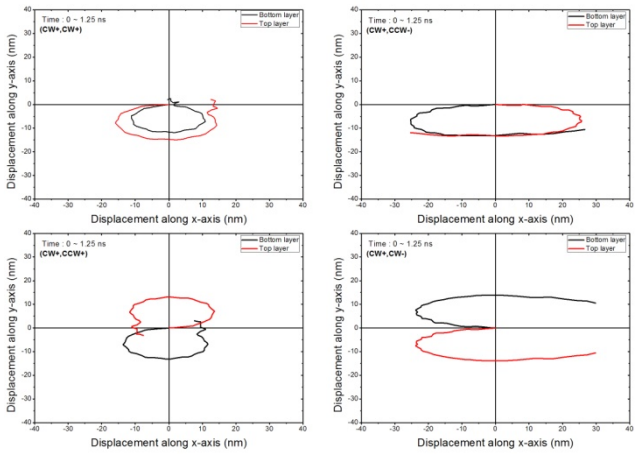


Fig.3 Initial trajectory of a vortex core (during 1.25 ns) depending on 4 different magnetic configurations.

References

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