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Vortex pair dynamics in a confined system

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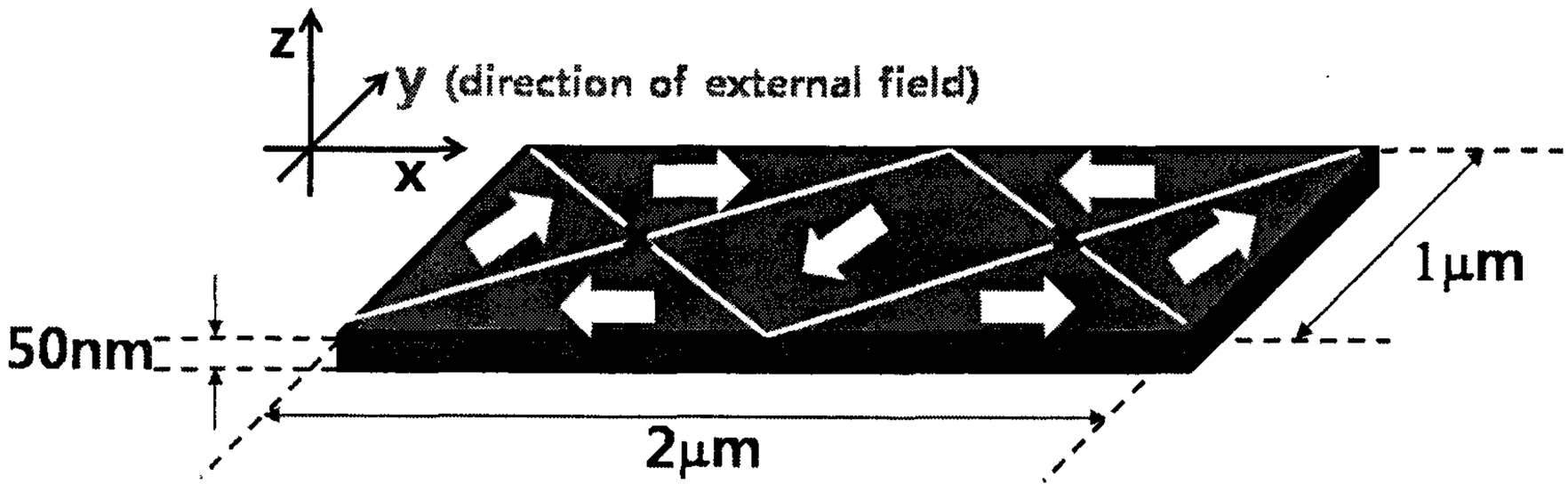
1. introduction

Vortex state is the one of the equilibrium configurations of the ferromagnetic materials [1]. It has both close-flux curling magnetization and out-of-plane magnetization by competing magnetostatic energy and exchange energy [2]. Because both vortex core and in-plane spiral magnetization could be used as data carriers, the vortex state could be a powerful candidate for a high density memory.

2. model and calculation

Here, we performed a micromagnetic simulation using of the Landau-Lifshitz-Gilbert equation (eq. 1) to understand vortex dynamics in paired vortex system; 2um x 1um of rectangular, which has 50nm thickness, permalloy (NiFe) (Fig. 1). After paired vortex core was formed, the external magnetic field was applied for 1.2ns considering rise and fall time. Vortex dynamics was studied under controlling two variables: polarity of vortex core and size of external magnetic field.

$$\frac{\partial \mathbf{M}}{\partial t} = -\gamma\, \mathbf{M}\times\mathbf{H} + \frac{\alpha}{M_S}\mathbf{M}\times\frac{\partial \mathbf{M}}{\partial t} \quad (\text{eq.1})$$



(Fig. 1.)

✖ : vortex core ⇨ :direction of magnetization

3. result and discussion

The single vortex core dynamics in the magnetic field is studied well. [3] The movement of vortex core is governed by its polarity and chirality. In a paired vortex structure, movement of vortex core is very similar with single vortex system. However, in a paired vortex structure,

vortices showed in-phase and out-of-phase motion depending on its polarity. Also, the frequency and trajectory of vortex core were different from single vortex system. In a sufficient high magnetic field, vortex core splitting and vortex core switching were observed.

[1] Shinjo, T., Okuno, T., Hassdorf, R., Shigeto, K. & Ono, T. Magnetic vortex core observation in circular dots of permalloy. Science 289, 930-932 (2000).
[2] Miltat, J. & Thiaville, A. Vortex cores-smaller than small. Science 298, 555 (2002).
[3] S.-B. Choe, et al. Vortex core-driven magnetization dynamics. Science 304, 420 (2004).