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Comparison of Writing Window between Single Layer and Synthetic Ferrimagnets

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1. Introduction

Synthetic ferrimagnets (SyF), which are composed of two magnetic layers sandwiching a very thin non-magnetic spacer, continue to play a key role in advanced magnetic devices. One important example of such an application is the use of a SyF as a free layer structure in high density magnetic random access memory (MRAM) [1, 2]. The advantages over conventional single magnetic layers include small cross-talk effects, coherent magnetization switching, and a high magnetoresistance ratio. Most of these advantages are related to the formation of a flux closure structure in the trilayers. It was recently reported that SyF has an additional advantage of low critical current density for current-induced magnetization switching (CIMS) in spin transfer torque (STT) MRAM [3]. However, the writing window which is important in designing current lines for stable operation is not reported yet. In this work, we investigated writing window of single layer and SyF with varying thickness asymmetries in both static and dynamic manner.

2. Computational method

For both single layer and SyF, cells are elliptical in shape with lateral dimension of 160 nm x 80 nm. Thicknesses of single magnetic layer is 2 nm and total thickness of SyF is 4 nm, however thickness asymmetry is varied. Thickness of spacer is 0.6 nm. The magnetic parameters used were: M_s = 1034 emu/cc; K_u = 5170 erg/cm^3, J_{ex} = -0.17 erg/cm^2. Total energy of single layer and SyF in equilibrium state were calculated from recently introduced new methods [4, 5]. In static manner, critical field is defined as the field where stability is lost. In other words, it is the field where reversible process ends. In dynamic manner critical field is defined as the field where total energy of initial state and saddle point coincides, since magnetization dynamics will explore virtually all the energy surface which includes a path of continuously decreasing energy [6].

3. Results and discussion

Figure 1 shows writing window of single layer and SyF with varying thickness asymmetries in dynamic manner. Writing window of SyF with large thickness asymmetry shows almost same behavior as that of single layer. However, different behavior is observed in writing window of SyF with small thickness asymmetry. Rather large window occurs in highly inclined field region. This fact can be understood as that SyF with small thickness asymmetry is better for designing current lines, since large current (magnetic field) can be flown through this region.

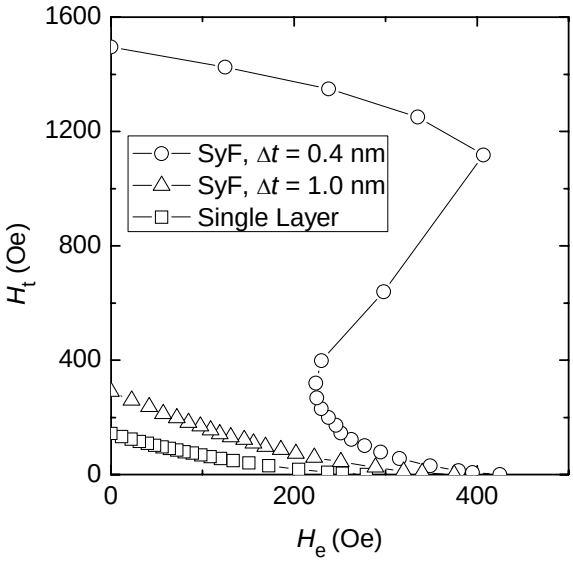

Figure 1. Writing window of single layer and SyF with varying thickness asymmetries in dynamic manner.

4. References

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