CS01

Numerical Study of the Exchange Bias in Magnetic Systems with a Heterogeneous Morphology

Yong Hu, An Du*, and Ze Xianyu

College of Sciences, Northeastern University, Shenyang 110004, People's Republic of China

*Corresponding author: An Du, e-mail: du_an_neu@126.com

Interest in exchange bias (H_E) of ferromagnetic (FM)/antiferromagnetic (AF) systems has increased in the past few years by virtue of their potential for applications in fields such as ultrahigh-density magnetic recording [1]. For a heterogeneous model system consisting of exchange-coupled AF and FM phases with composition $(FM)_x + (AF)_{1-x}$, a modified Monte Carlo Metropolis method based on three-dimension classical Heisenberg model is performed [2]. Motivated by recent experimental findings, we focus on the influences of field-cooling strength and interfacial anisotropy on the H_E, vertical magnetization shift (M_E), and coercivity (H_C). We find that when FM and AF anisotropy axes are parallel to each other on the FM / AF interface, both $|H_E|$ and M_E decrease monotonously with increasing x, even linearly after applying a large cooling field (Figs. 1(a) and (c)). The proportion of M_E to $-H_E$ is valid also for this model ($h_{CF} = 8$ in Fig. 1(d)), agreeing with the experimental findings [3, 4]. Whereas H_C is only weakly influenced for small x and has a sharp increase as $x > 0.6$ (Fig. 1(b)). For the interface with randomly oriented anisotropy axes, H_E and H_C are non-monotonously dependent on x and exhibit the extrema at $x = 0.2$ and $x = 0.6$, respectively (Figs. 2(a) and (b)). However, M_E is smaller for a larger x (Fig. 2(c)). The results indicate that the linear relation between H_E and M_E is not satisfied in the case of randomly oriented anisotropy axes on the FM / AF interface. For small x and the interface with uniformly oriented anisotropy axes, larger cooling fields produce more pinned uncompensated spins in the AF phase to induce large $|H_E|$, M_E, and H_C via the FM / AF interfacial exchange interaction. While the influence of the increased interfacial area at intermediate x on H_E and H_C emerges only for the interface with randomly oriented anisotropy axes. Not only the value but also the tendency of exchange bias effect is affected by FM / AF interface in FM_x / AF_{1-x} heterogeneous systems strongly. The simulated results are consistent with some experimental facts [5].

This work is supported by the Shenyang Applied Basic Research Foundation of China under contract number 1071199-1-00-2.

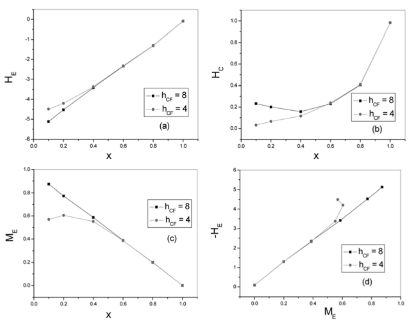

Fig. 1. The exchange bias field(a), coercivity(b), and vertical magnetization shift(c) of system with uniformly oriented interfacial anisotropy axes as functions of x with different cooling fields at $T = 0.05$. (d) The exchange bias as a function of vertical magnetization shift extracted from (a) and (c).

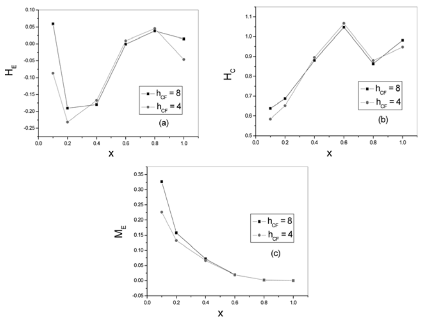

Fig. 2. The exchange bias field(a), coercivity(b), and vertical magnetization shift(c) of system with randomly oriented interfacial anisotropy axes as functions of x with different cooling fields at $T = 0.05$.

REFERENCES

[1] V. Skumryev *et al.*, Nature 423, 850 (2003).
[2] Y. Hu and A. Du, J. Appl. Phys. 102, 113911 (2007).
[3] D. Niebieskikwiat and M. B. Salamon, Phys. Rev. B 72, 174422 (2005).
[4] V. Markovich *et al.*, Phys. Rev. B 77, 054410 (2008).
[5] L. Del Bianco *et al.*, Phys. Rev. B 77, 094408 (2008).

CS02

Growth of Nanostructured Thin Films Deposited on Porous Aluminium Oxide

Y. O. Park, H. Ko, I. J. Park, S. J. Kim, I. B. Shim, C. S. Kim, and T. Kouh*

Department of Physics, Kookmin University, Seoul 136-702, Korea

*Corresponding author: Taejoon Kouh, e-mail: tkouh@kookmin.ac.kr

Anodic aluminium oxide has been gaining much attention due to the formation of a highly ordered porous structure. Furthermore, since the detailed structural properties such as the size of pores can be easily controlled with the anodization parameters, this self-ordered porous structure is very appealing as an alternate method of fabricating various nanostructures and devices. We have fabricated an anodic aluminium oxide with two-step anodization technique [1]. On top of the prepared porous aluminium oxide, we have deposited $CuAlO_2$ and Mn thin films by RF-sputtering and molecular beam epitaxy methods under various conditions, and performed morphology studies on these films. The $CuAlO_2$ films have been sputtered onto the substrate at room temperature with Ar flow of 20 sccm. We have varied the film thickness by changing the deposition time ranging from 15 minutes to 1 hour at the fixed RF power of 50 W. Also, Mn film with thickness of 500 Å has been deposited on to the substrate at room temperature with molecular beam epitaxy method at a rate of 0.1 Å/s. Our preliminary results show that the $CuAlO_2$ films show the formation of grains with increase in thickness, while Mn film shows the uniform coverage on the porous substrate. We will present the detailed experimental results on these thin films, and discuss the growth of the nanostructured thin films and the effect of the underlying structure of the anodic aluminium oxide substrate on the growth mechanism.

This work is supported by the Korea Research Foundation Grant funded by the Korean Government (KRF-2008-331-C00090).

REFERENCES

[1] H. Masuda and K. Fukuda, Science, 268, 1466 (1995).