

CS01

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

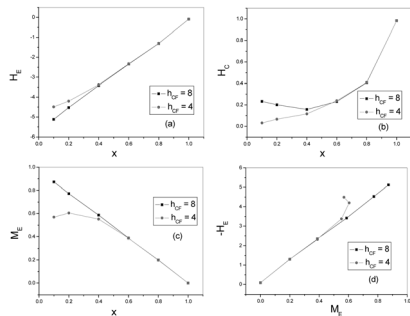
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Interest in exchange bias ( $H_E$ ) of ferromagnetic ( $FM$ )/antiferromagnetic ( $AF$ ) systems has increased in the past few years by virtue of their potential for applications in fields such as ultrahigh-density magnetic recording [1]. For a heterogeneous 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).

CS02

## Growth of Nanostructured Thin Films Deposited on Porous Aluminium Oxide

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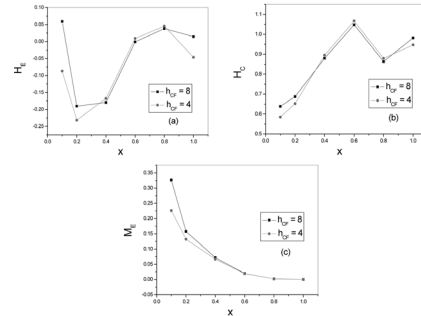
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Anodic aluminium oxide has been gaining much attention due to the formation of a highly ordered porous structure. Furthermore, since the detailed structural properties such as the size of pores can be easily controlled with the anodization parameters, 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  $\text{CuAlO}_2$  and Mn thin films by RF-sputtering and molecular beam epitaxy methods under various conditions, and performed morphology studies on these films. The  $\text{CuAlO}_2$  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 the substrate at room temperature with molecular beam epitaxy method at a rate of 0.1 Å/s. Our preliminary results show that the  $\text{CuAlO}_2$  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

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**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  $T = 0.05$ .

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