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Annealing Effect on Magnetic Properties of Sputtered Sm-Co Films

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Thin films fabricated by permanent magnetic materials have attracted attention continuously from the viewpoint of practical applications to magnetic recording media and microelectro-mechanical systems. The Sm-Co is suit for thin film magnets due to its high magnetocrystalline anisotropy ($K_u \sim 10^8$ erg/cm^3) and high Curie temperature. Further, high K_u material is a good way to overcome superparamagntic effect for ultrahigh density magnetic recording media. In this study, the Sm-Co films were deposited on cleaning glass substrates by the dc magnetron sputtering in a UHV chamber. The base pressure of the system was less than $3*10^{-9}$ torr and the high purity argon of $1.5*10^{-3}$ torr was flown during sputtering. The Sm-Co films were *deposited on heated substrate temperature* T_s of 300 to 600℃ and the films thickness varied from 170 to 450 nm. The protective layer Cu with thickness 36 nm was deposited on the Sm-Co film to against oxidation. The magnetic properties were measured by a vibrating sample magnetometer (VSM) with a maximum in-plane applied field of 18 kOe at room temperature. The structure of films was identified by x-ray diffraction (XRD), the PHILIPS PW3040/60. The microstructure of films was investigated byhigh resolution transmission electron microscopy (HRTEM). The composition of the Sm-Co film was $Sm_{13}Co_{87}$ measured by energy dispersive x-ray spectroscopy (EDS). In this study, we explore the magnetic properties and microstructure of the Sm-Co films with in-situ and post annealing processes. According to the XRD patterns, the Sm_2Co_{17} phase with (111), (110), (201) diffraction peaks were identified for film deposited at 300 to 400℃. Figure 1(a) and (b) show the M-H loops of glass//Sm-Co/Cu thin films with various substrate temperatures. The in-plane coercivity (H_c) increased from 2.50 kOe (T_s =300℃) to the maximum value of 6.17 kOe (T_s =400℃), and then decreasing to 2.02 kOe at 500℃. The H_c was deteriorated at about 450℃. The magnetic properties and microstructure of the Sm-Co films with *post annealing process will* be discussed.

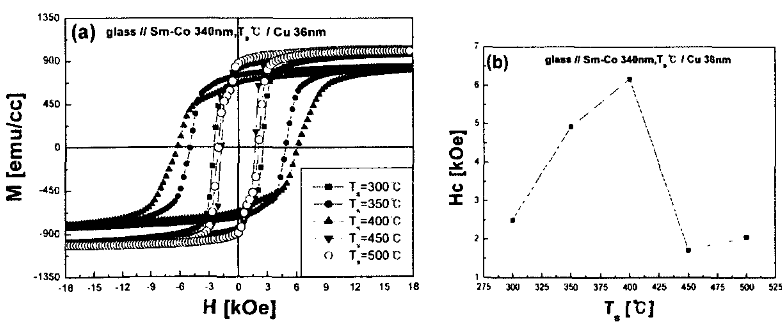

Fig. 1. The M-H loops of glass//Sm-Co/Cu thin films with various substrate temperature (a) and the coercivity versus various substrate temperature are plotted, respectively.

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Effect of Additives on the Magnetic Properties and Microstructure of Melt Spun $SmCo_{6.9}Hf_{0.1}M_{0.1}$ (M = B, C, Cu, Nb, Si, Ti) Ribbons

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The rare-earth transition metal intermetallic Sm - Co compounds with a $TbCu_7$ structure have received intensive attention due to high magnetocrystalline anisotropy field and high saturation magnetization.[1-5] However, the $SmCo_7$ phase is metastable, and it could be obtained by either melt spinning or mechanical alloying technique containing a small amount of the third metallic element in $SmCo_{7-x}M_x$ alloy (M = Ag, Cu, Ga, Hf, , Si, Ti, and Zr).[2-5] Among them, Hf is the most beneficial element in stabilizing 1:7 phase and enhancing its magnetocrystalline anisotropy, yet having higher saturated magnetization.5 In our previous studies [6], the optimal magnetic properties of B_r = 6.4 kG, $_iH_c$ = 7.3 kOe and $(BH)_{max}$ = 8.7 MGOe could be obtained for x=0.1 in $SmCo_{7-x}Hf_x$ series ribbons. For isotropic nanocomposites, fine microstructure is necessary to obtain the excellent magnetic performance. The additives, including B, C, Cu, Nb, Si, Ti, were reported to be helpful to refine the grain size in various nanocomposite ribbons. Therefore, effect of those additives on the magnetic properties, phase evolution, and microstructure of $SmCo_{6.9}Hf_{0.1}M_{0.1}$ ribbons by melt spinning technique under sufficient supercooling condition have been investigated. Among them, C was found the most helpful element to refine the grain distribution from 100-400 nm for C-free to 10-80 nm for C addition. C is easy to combine with Sm to form samarium carbide in the grain boundary, which not only leaves a small volume fraction of free Co in the matrix, but also impedes the grain *growth. Accordingly, magnetic properties* of Br = 6.8 kG, $_iH_c$ = 11.8 kOe and $(BH)_{max}$ = 10.2 MGOe could be achieved for $SmCo_{6.8}Hf_{0.1}C_{0.1}$ nanocomposite ribbons.

REFERENCES

[1] K. H. J. Buschow, Van der Goot, Acta Cryst. B 27, 10859(1971).
[2] M. Q. Huang, W. E. Wallace, M. McHenry, Q. Chen, and B. M. Ma, J. Appl. Phys. 83, 6718 (1998).
[3] I. A. Al-Omari, Y. Yeshurun, J. Zhou, and D. J. Sellmyer, J. Appl. Phys. 87, 6710 (2000).
[4] Chengbao Jiang, M. Venkatesan, K. Gallagher, J. M. D. Coey, J. Magn. Magn. Mater. 236, 49 (2001).
[5] J. Luo, J. K. Liang, Y. Q. Guo, L. T. Yang, F. S. Liu, Y. Zhang, Q. L. Liu, and G. H. Rao, Appl. Phys. Lett. , 85, 5299(2004).
[6] H.W. Chang, S.T. Huang, C.W. Chang, C.H. Chiu, W.C. Chang, A.C. Sun, and Y.D. Yao, J. Appl. Phys. (2007) accepted for publication.