TC03

Effect of Co Underlayer on the Magnetic Properties and Microstructures of TbCo Films

S. C. Chen*[1], P. C. Kuo[2], P. L. Lin[2], Y. Li[2], and Y. H. Fang[2]

[1] Department of Materials Engineering, MingChi University of Technology, Taipei 243 and Center for Nanostorage Research, National Taiwan University, Taipei 106, Taiwan

[2] Institute of Materials Science and Engineering and Center for Nanostorage Research, National Taiwan University, Taipei 106, Taiwan

*Corresponding author: sscchh(@ms28.hinet.net, Phone: +886-2-23648881, Fax: +886-2-23634562

The amorphous TbCo alloy film has excellent perpendicular anisotropy and large perpendicular coercivity ($Hc_\perp$) to resist thermal agitation of the magnetic moments, it is a promising material for heat-assisted magnetic recording (HAMR) media application [1]. However, the small saturation magnetization (Ms) at room temperature of TbCo film makes it difficult detection by giant magnetoresistive (GMR) head. In this study, a ferromagnetic Co film with large Ms value is introduced under ferrimagnetic TbCo film in an attempt to enhance its magnetic properties.

The $Tb_{30}Co_{70}$ filmwith thickness of 90 nm is deposited on naturally oxidized Si wafer by dc magnetron co-sputtering of Tb and Co targets. The TbCo film is sandwiched with SiNx which prepared by rf magnetron sputtering of SiN target to prevent oxidation. The $Hc_\perp$ and the Ms values of the $Tb_{30}Co_{70}$ film are about 4610 Oe and 194 emu/cm^3, respectively. As introducing a 3 nm Co underlayer under to the $Tb_{30}Co_{70}$ film, the $Hc_\perp$ and the Ms values of TbCo/Co bi-layer films are increased to 4630 Oe and 264 emu/cm^3, respectively. When the thickness of Co underlayeris further increased to 15 nm, they are further increased to 6410 Oe and 330 emu/cm^3, respectively. The increase of $Hc_\perp$ value may be attributed to the exchange coupling [2] at the interface between ferrimagnetic TbCo and ferromagnetic Colayer. The enhancement of Ms value is due to the contribution of the ferromagnetic Co layer which has large Ms value. As shown in Fig. 1, the HRTEM cross-sectional image shows that the $Tb_{30}Co_{70}$ film is still kept at amorphous state after introducing the amorphous-like Co underlayer that is consistent with XRD observation.

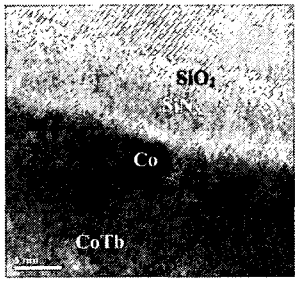

Fig. 1. The cross-sectional HRTEM image of the CoTb/Co/SiN_X/SiO_2/Si multilayer films.

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TC04

Interfacial Energy in $Tb_{29.3}Co_{70.7}$ /$Tb_{17.2}Co_{82.8}$ Bilayer Films

Y. H. Fang*[1], P. C. Kuo[1], C. T. Kuo[1] and T. Y. Huang[1]

[1] Institute of Materials Science and Engineering, National Taiwan University, 106 Taipei, Taiwan

*Corresponding author: d93527014@ntu.edu.tw, Phone: +886 2 23648881, Fax: +886 2 23634562

The $Tb_{29.3}Co_{70.7}$(RE-rich)/$Tb_{17.2}Co_{82.8}$(TM-rich) bilayer films which sandwiched between two Si_3N_4 protected layers were fabricated to investigate their interfacial exchange energy $\Delta\sigma$. The interfacial energy of this TbCo/TbCo bilayer films can be derived from the following equation[1,2] :

$$\Delta\sigma = 2H \times Ms \times t,$$

where H, Ms, t are the biasing field, saturation magnetization and thickness of $Tb_{29.3}Co_{70.7}$ (RE-rich) layer. $\Delta\sigma$ of the TbCo/TbCo bilayer films estimated from hyteresis loop of $Tb_{29.3}Co_{70.7}$ /$Tb_{17.2}Co_{82.8}$ bilayer films at room temperature (Fig. 1), is about 4.2 erg/cm^2, which is higher than that in the FM/AFM systems by two times.[3,4] Based on the experiment results, we suggest that this strong exchange energy may be owing to the increase of the amount of uncompensated spins at the interface of $Tb_{29.3}Co_{70.7}$/$Tb_{17.2}Co_{82.8}$ bilayer film which is due to high roughness between TbCo/TbCo bilayer films that is caused by the high roughness between TbCo and Si_3N_4 under layer.[3-4] From cross-sectional TEM image (Fig. 2.) of Si/Si_3N_4/ $Tb_{29.3}Co_{70.7}$/$Tb_{17.2}Co_{82.8}$/Si_3N_4 film, it is found that the interface between Si_3N_4 and $Tb_{29.3}Co_{70.7}$ films is rough. From the relationship between $Hc_\perp$ value of the $Tb_{29.3}Co_{70.7}$/$Tb_{17.2}Co_{82.8}$ bilayer films and temperature, it is found that the $Hc_\perp$ value decreases rapidly from 5200 to 250 Oe as the temperature increases from 25 to 300℃. This rapid decrease of $Hc_\perp$ with temperature satisfies the writing requirement of heat-assisted magnetic recording (HAMR) medium.

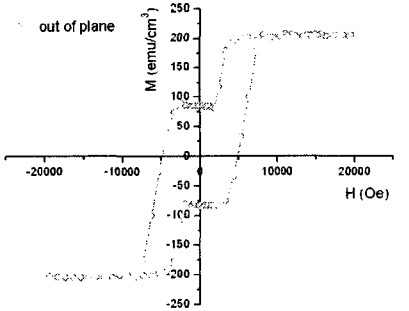

Fig. 1. Hyteresis loop of $Tb_{29.3}Co_{70.7}$/$Tb_{17.2}Co_{82.8}$ bilayer films at room temperature.

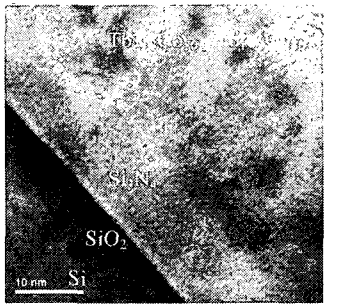

Fig. 2. The cross-sectional TEM image of the Si/Si_3N_4/$Tb_{29.3}Co_{70.7}$/$Tb_{17.2}Co_{82.8}$/Si_3N_4 films.

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