S-6

Effects of composition on the magnetic properties and perpendicular anisotropy of NdFeB thin films

KRISS J.H. Yang*, M.J. Kim*, K.S. Ryu, Y.T. Park Y.B. Kim
* Chungnam National University T.K. Kim

1. Introduction

Since the discovery of NdFeB magnet [1-3], many researches have focused on their magnetic properties and applications. Thin film magnets have potential applications on micro-motors, actuators and high-density magnetic recording media etc. The high energy with perpendicular anisotropy is desired for high-performance micro devices.

In this work, we have investigated the compositional effects on the magnetic properties and perpendicular anisotropy of NdFeB thin films.

2. Experimental

The [Ta/NdFeB/Ta]-type films were deposited from $Nd_{17}Fe_{74}B_9$, $Nd_{12}Pr_4(Fe,Co)_{78}B_6$ and $Nd_{14}(Fe,Co)_{80}B_6$ target onto heated Si(100) substrates by dc magnetron sputtering. The base pressure was below $2x10^{-6}$ Torr and the Ar gas pressure during sputtering was fixed at 5 mTorr.
The crystalline structure was examined by x-ray diffractometry with Cu K_α radiation and scanning electron microscopy. Magnetic properties were measured by a vibrating sample magnetometer (VSM) along parallel and perpendicular to the film plane after premagnetizing at a pulsed field of 90 kOe..

3. Results and discussions

Fig.1 shows the $M_r(\parallel)/M_r(\perp)$, which indicated the alignment of tetragonal $Nd_2Fe_{14}B$ to film plane, as a function of substrate temperature(T_s) for target composition. The perpendicular anisotropy is developed with the increase of rare earth content, from in-plane anisotropy in $Nd_{14}(Fe,Co)_{80}B_6$, via intermediate state in $Nd_{12}Pr_4(Fe,Co)_{78}B_6$ to a strong perpendicular anisotropy in $Nd_{17}Fe_{74}B_9$ film.

Fig.2 shows the variation of perpendicular $_iH_c$ for each target and substrate temperature. The coercivity of the films increases considerably according to the increase of rare earth element. The

optimum coercivity is observed at around T_s=650 ℃ for all targets. It is considered to be formed the optimum grain size of $Nd_2Fe_{14}B$ phase at around 650 ℃ for high coercivity, as will be discussed later in detail.

4. Conclusion

[Ta/NdFeB/Ta]-type films, whose target composition is $Nd_{17}Fe_{74}B_9$, $Nd_{12}Pr_4(Fe,Co)_{78}B_6$ and $Nd_{14}(Fe,Co)_{80}B_6$, were DC-sputtered onto Si at the substrate temperature of 600-750 ℃. The perpendicular anisotropy was developed with the increase of rare earth element, and the $Nd_{17}Fe_{74}B_9$ film prepared at the substrate temperature of 650 ℃ showed a superior magnetic properties of B_r=1.22 T, $_iH_c$=790 kA/m(~9.9 kOe) and $(BH)_{max}$=278 kJ/m^3(~35 MGOe) along perpendicular to film plane

5 .Reference

[1] F.J. Cadieu, T.D. Cheung, L. Wickramasekara and N. Kamprath, IEEE Trans. Magn. 22(5), 752(1986)

[2] B.A. Kapitanov, N.V. Kornilov, Ya.L. Linetsky, V.Yu. Tsvetkov, J. Magn magn. Mater., 127, 289(1993).

[3] H. Sun, T. Tomida, S. Hirosawa, Y. Maehara J.Magn. Magn. Mater., 164, 18(1996)

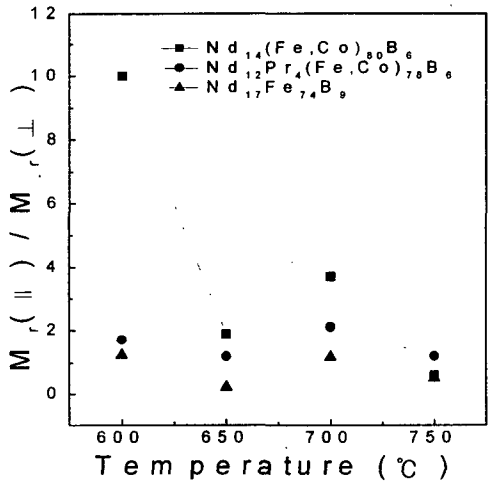

Fig.1 The $M_r(\parallel)/M_r(\perp)$ as the function of substrate temperature and target composition

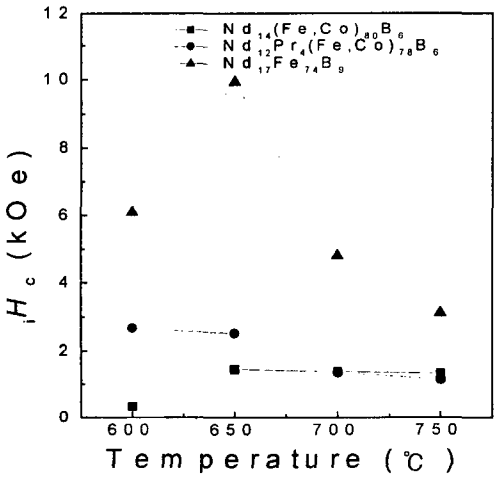

Fig.2. The perpendicular $_iH_c$ for each target and substrate temperature.