17a-S2-10

Exchange interaction in Co/Tb/Co trilayer structures

Q.Y. Xiang[1,2,3], Z.C. Wen[2,3], H. Sukegawa[2,3] and S. Mitani[1,2,3]
[1]Graduate School of Pure and Applied Sciences, Univ. Tsukuba, [2]National Institute for Materials Science, [3]Elements Strategy Initiative Center for Magnetic Materials
E-mail: xiang.qingyi@nims.go.jp

Rare earth (RE) based nanostructures bring about remarkable magnetic properties in a wide area of magnetics. Recently, RE rich very thin layered structures were found in the grain boundary of sintered NdFeB permanent magnets,[1] and exchange coupling through a rare earth based layer is believed to be of particular importance to understand magnetic properties of RE based permanent magnets as well as RE based perpendicularly magnetized thin films used for recording media and magnetic memory devices. In layered structures consisting of ferromagnetic transition metal (TM)/nonmagnetic TM/ferromagnetic TM and ferromagnetic TM/noble metal/ferromagnetic TM, interlayer exchange coupling (IEC) was first reported in Fe/Cr/Fe.[2] When two ferromagnetic layers are separated by a space layer of TM or noble metal, the exchange coupling strength and the coupling type vary as a function of the thickness of the space layer.[3] However, there have been only few reports on IEC in TM/RE/TM systems so far. In this study, we investigated the IEC in TM/RE/TM (TM=Co etc., RE=Tb etc.) trilayer structures.

Co/Tb/Co trilayers were fabricated by using a magnetron sputtering system on a thermally oxidized Si substrate (Si/SiO_2) with a base pressure of around 1×10^{-7} Pa. The structure prepared is as follows (thickness in nm): Si/SiO_2// Ta(5)/ Co(2.5)/ Tb(t_{Tb})/ Co(4)/ Ta(5), where t_{Tb} is the thickness of the Tb layer, namely a space layer. 5-nm-thick Ta films act as seed and cap layers. All the layers were sputter-deposited from the corresponding targets of the high purity metals, and the sputtering conditions of rf/dc power of 10-100W and Ar gas pressure of 0.2-0.25 Pa were used. Magnetization curves were measured by a vibrating sample magnetometer (VSM).

The saturation field (H_s) and remanence (M_r) as a function of Tb layer thickness (t_{Tb}) for the Co/Tb/Co trilayers are shown in Fig. 1. H_s and normalized M_r show non-monotonic dependence on t_{Tb}, suggesting that there exists exchange interaction between the Co layers. It is noted that the steep increase around t_{Tb}=0.8 nm has been well confirmed by repeating the experiments and that the saturation magnetization (M_s) monotonically deceases with increasing t_{Tb} possibly due to antiferromagnetic exchange coupling between Co and Tb atoms at the intermixing region of the interface. The observed behavior of H_s and M_r/M_s will be discussed in terms of possible oscillatory ICE, perpendicular magnetic anisotropy and the effect of intermixing.

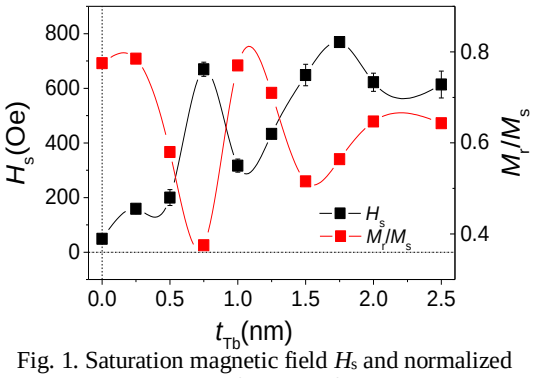

Fig. 1. Saturation magnetic field H_s and normalized remanence M_r/M_s as a function of Tb spacer layer thicknesses t_{Tb} in Co/Tb/Co trilayer structures.

References:

[1]H. Sepehri-Amin, T. Ohkubo, T. Shima, and K. Hono, Acta. Mater. **60,** 819 (2012).

[2]P. Grunberg, R. Schreiber, Y. Pang, M.B. Brodsky, and H. Sowers, Phys. Rev. Lett. **57,** 2442 (1986).

[3]S. S. P. Parkin, N. More, and K. P. Roche, Phys. Rev. Lett. **64,** 2304 (1990).