Magnetization compensation temperature and field-driven domain wall creep motion in ferrimagnetic Tb/CoFeB/MgO layer

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Transition-metal and rare-earth (TM-RE) ferrimagnetic materials, in which the two magnetic sublattices are antiferromagnetically coupled, are widely used materials for magneto-optical recording etc. Recently it was demonstrated that the spin-orbit-torque efficiency is maximized at magnetization compensation temperature T_M due to the decrease of the net magnetization [1], and the fast magnetic domain wall (DW) dynamics at angular momentum compensation temperature T_A due to the antiferromagnetic spin dynamics [2]. Therefore TM-RE ferrimagnetic materials have a potential to lead to high-speed spintronic devices. In terms of materials, CoFe(B)/MgO junctions are practically important in the field of spintronics, since they exhibit a giant tunnel magnetoresisntance, a large perpendicular magnetic anisotropy, and voltage-control of magnetic anisotropy. In this study, we report the observation of ferrimagnetic properties of CoFeB/MgO junctions using Tb underlayer, where there is a large antiferromagnetic exchange coupling between the magnetic moments of CoFeB and Tb.

The films were prepared by sputter deposition on a thermally oxidized Si wafer: Ta(3.0) / Tb(5.0) / $Co_{20}Fe_{60}B_{20}$(t_{CoFeB}) / MgO(1.1) / Ta(1.0) (thickness in nm). To estimate T_M, we measured the temperature dependence of magnetic moment, as shown in Fig. 1. T_M was clearly observed in the t_{CoFeB} range from 0.8 to 1.6 nm. This is due to the antiparallel alignment between the CoFeB and Tb moment through the antiferromgnetic exchange coupling. Field-driven DW dynamics in a creep region were then investigated using a real-time DW detection method. In the presentation, we will report the CoFeB thickness dependence of field-driven magnetic domain wall dynamics in a creep region.

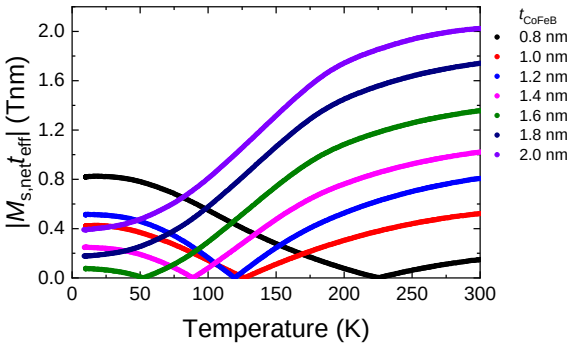

Figure 1 Temperature dependence of $|M_{s,net}t_{eff}|$ for various t_{CoeB} obtained from SQUID measurement.

[1] J. Finley and L. Liu, *Phys. Rev. Appl.* **6**, 054001 (2016) [2] K.-J. Kim *et al.*, *Nat. Mater.* **16**, 1187 (2017)

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