Effect of ultrathin Tb layer on current driven domain wall motion in Co/Tb magnetic bilayers

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Current-driven magnetic domain wall (DW) motion and magnetization switching have attracted much attention for new applications, such as nonvolatile magnetic memory. The driving force of the domain wall motion is attributed by Spin Transfer Torque (SST) and Spin Orbital Torque (SOT). The STT is well studied; however, SOT is still under investigation. We have reported about the DW motion with rare earth-transition metal (RE-TM) magnetic wires, in which the critical current density (J) of the DW motion can be reduced due to the small magnetization of the ferromagnetic RE-TM material [1,2]. On the other hand, we also need to consider the SOT of the RE atom, since it possess large spin orbital interaction [3].In particular, the results show that the efficiency of SOTs is highest for the samples with a large number of inner Co/Tb interfaces and lowest for the Tb-Co alloy magnetic ones. However, such an enhancement in thick multilayers has not yet been fully understood.

In this work, we investigate the SOTs generated from a Co/Tb interface in Ta(3 nm)/Pt(3 nm)/Co(0.9)/Tb(t nm)/Ta(3 nm)/Pt(1.5 nm), (t) from 0 to 5 nm, Pt/Co/Tb/Ta heterostructures. Layers of were deposited on the thermally oxidized silicon substrates.

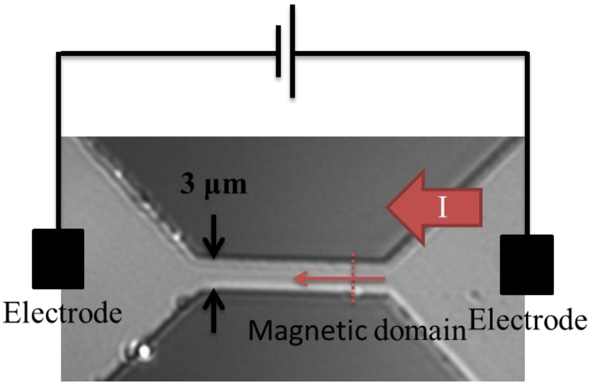

Fig.1 A polar Kerr microscope image of the magnetic wire

In order to observe the current-induced DW motion, current pulses of 100-ns duration is applied between two electrodes as shown in Fig.1. The Tb-thickness dependence of DW velocity is shown in Fig.2 for a 3-µm width wire. When Tb thickness increases the DW velocity increases. In addition, we also found that the J_C decreases with increasing the Tb thickness increasing. It suggests that the increasing of Tb layer thickness can enhance the spin-orbit torque.

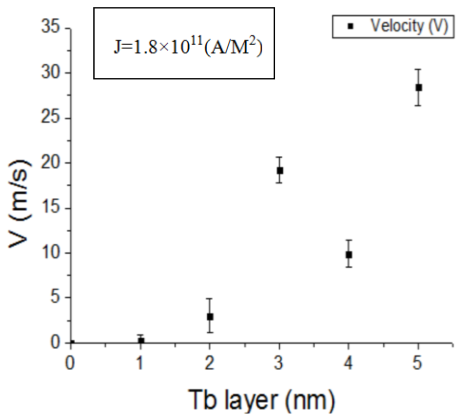

Fig.2 The relationship Tb thickness between DW motion velocity was plotted at fixed current.

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