

Modeling switching current in synthetic anti-ferromagnetic spin valve structure

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Recently, current induced magnetization switching (CIMS) has been demonstrated in the spin valve structure. The spin-transfer torque switching provides various merits in storage device as compared with the magnetic field switching. For the application of CIMS in the spin-transfer torque random access memory, two important issues should be solved, i.e. how to reduce the switching current density (J_c) and how to increase the thermal stability. The synthetic anti-ferromagnetic structure (SAF) is proposed to improve the thermal stability. In SAF, two magnetic free layers are coupled by magnetostatic field of each free layer and Ruderman-Kittel-Kasuya-Yosida (RKKY) interaction. This coupling makes that the spin of magnetic layer is more stable than that of the single free layer structure. From the viewpoint of J_c , the study is not enough to predict accurate J_c in SAF. Therefore, we estimate J_c and thermal stability in SAF using macrospin simulation. We control free layer thickness and calculate the spin transport quantity which a free layer provides to another layer. Figure 1 shows current switching events at the single free layer structure. The geometry of the magnetic layer is $90 \times 30 \times 3$ (length \times width \times thickness) nm^3 . In SAF, the length and width and bottom free layer (FL1) thickness are fixed and top free layer (FL2) thickness is changed. We calculate switching probability at each current by 300 events and define J_c at 50% switching point. Figure 2(a) and (b) show J_c by varying thickness of FL2. It shows very asymmetric J_c depending on the initial magnetic configuration, caused by different spin-torque mediated coupling between free layers. We will demonstrate J_c in SAF and explain interaction between FL1 and LF2 when spin-torque is applied to free layers.

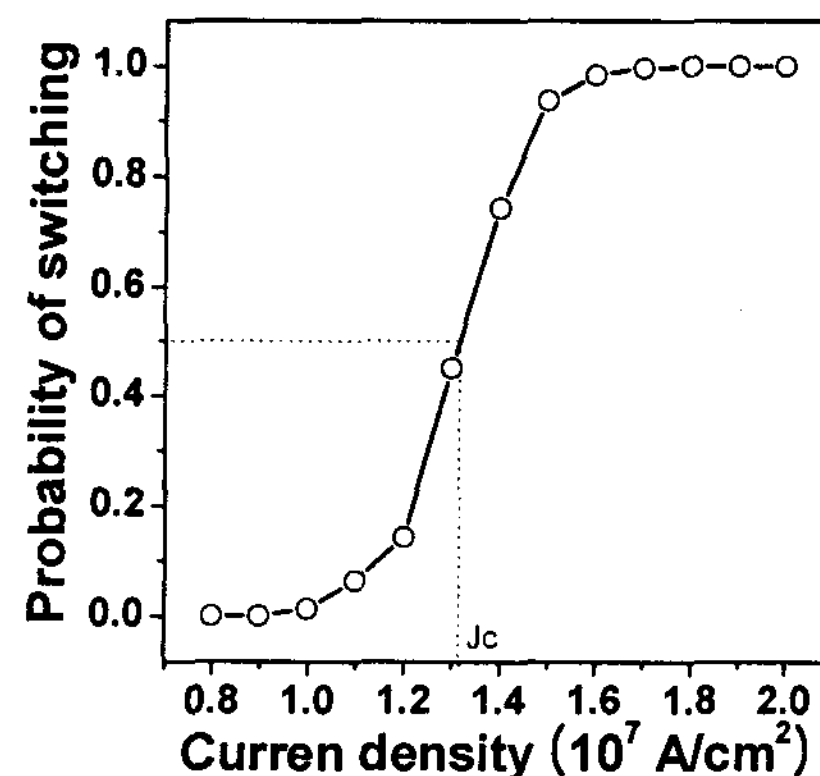
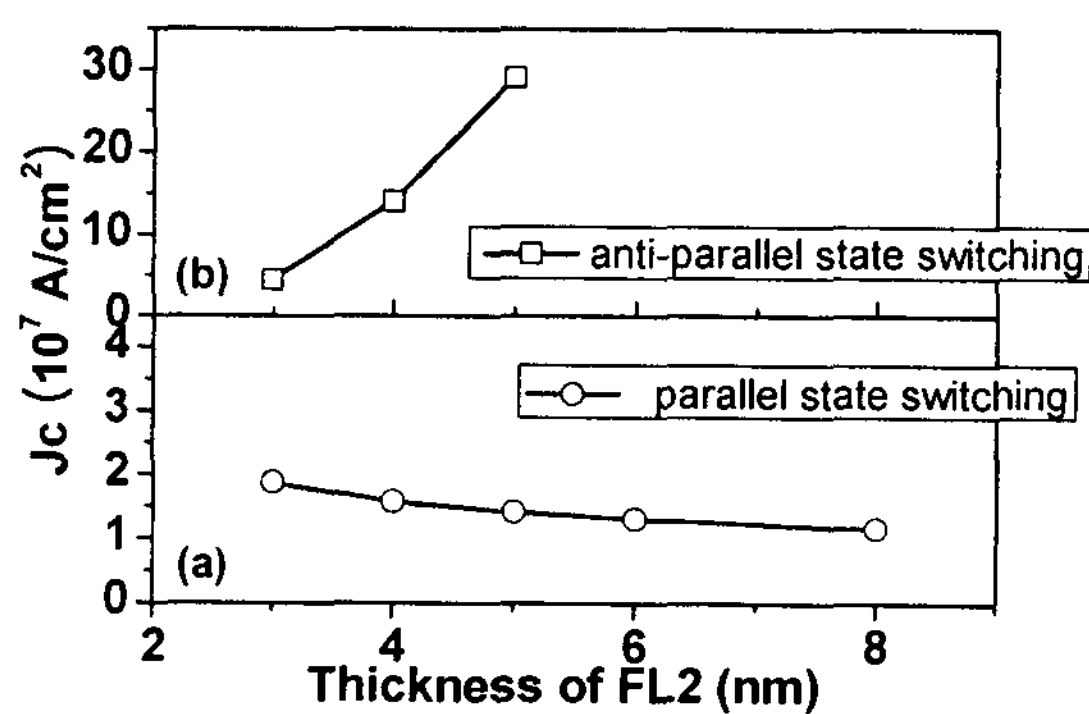


Fig. 1. Switching event in single free layer structure. Fig. 2. Switching current J_c in SAF.