Spin-orbit torque induced magnetisation dynamics and switching in CoFeB/Ta/CoFeB system with mixed magnetic anisotropy

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Spintronic devices development is important for the design of new energy-efficient storage and processing technologies [1]. Recently, spin Hall magnetoresistance and spin orbit torque (SOT) effects in the bilayers of heavy metals (HM), exhibiting large spin-orbit coupling (such as W [2], Ta [1] or Pt [3]) and ferromagnet (FM) have been intensively studied. For example. in Ta/CoFeB bilayers SOT-induced switching without external magnetic field [4], domain wall movement dynamics [5] and analog-memristor behaviour [6] have been reported. Here, we present FM/HM/FM system where the HM is used as a source of the spin current and as a tunable coupler between the two FM layers. Bottom and top $Co_{20}Fe_{60}B_{20}$ layers exhibit in-plane (IPMA) and perpendicular magnetic anisotropy (PMA), respectively [3]. The coercive field measured using anomalous Hall effect increases with decreasing t_{Ta} down to around 1 nm, alongside with an increase in SOT-induced switching current density. Ferromagnetic resonance measurements were also performed in order to determine the coupling energy via Ta spacer. Modelling the dispersion relation using Landau-Lifshitz-Gilbert equation for IPMA and PMA magnetized FM layers enabled determination of the saturation magnetisation, anisotropy energy and the interlayer coupling between the two FM. The decrease in t_{Ta} leads to a change from negligible coupling for $t_{Ta} = 8$ nm, through antiferromagnetic for $t_{Ta} = 1.4$ nm, to ferromagnetic coupling for $t_{Ta} = 0.72$ nm, where the field-free SOT-switching can be partially achieved.

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