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A Potential Spin-orbit Torque Device Using the Tri-layer Structure

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Abstract : How to develop spin-orbit-torque (SOT) devices with the virtues of field-free, perpendicular magnetic anisotropy (PMA), and low switching current is one of the many challenges in spintronics today. We propose a CoFeB/Ta/CoFeB tri-layer antiferromagnetic SOT device that could meet the above requirements. The device's PMA was developed by adopting CoFeB–MgO interface. The key to the success of this structure is to ensure that (i)changes of the inter-layer coupling(IEC) and CoFeB anisotropy can occur simultaneously; (ii) one of the CoFeB needs to have a slightly tilted moment in the beginning. When sufficient current is given, the SHEreverses the already-tiltedCoFeB, and the other CoFeB can be reversed simultaneously by the IEC with the field-free nature. Adjusting the thickness of Ta can modify the coupling state to reduce the switching current while the field-free nature was preserved. Micromagnetic simulation suggests that the Néel orange peel effect (NOPE) is non-negligible due to interface roughness and coupling effect in the presence of perpendicular anisotropy. Fortunately, the Néel field induced by the NOPE appears to favor the field-free reversal.

Keywords : CoFeB, spin-orbit torque, antiferromagnetic, MRAM, trilayer
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