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Vector measurements of the current induced effective fields in Ta/CoFeB/MgO heterostructures

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Ultrathin magnetic heterostructures exhibit a variety of rich physics owing to the strong effects from the interfaces. Power efficient current induced magnetization switching and domain nucleation, fast current driven domain wall motion have been observed in ultrathin Co or CoFeB layer sandwiched between a heavy metal (Pt, Ta) and an oxide. Most of the current (or voltage) induced effects in these systems can be represented by the "effective magnetic fields", which illustrate the strength and direction of the torque exerted on the magnetic moments. A comprehensive understanding of the effective fields is key to the development of magnetic nano-devices aimed for memory and logic applications. We have studied the current induced effective field vector in Ta|CoFeB|MgO heterostructure to reveal the underlying physics of the interaction between the magnetic moments and current in such structure. A low current lock-in detection scheme is used to evaluate the effective field vector. The CoFeB layer is perpendicularly magnetized owing to the interface magnetic anisotropy of CoFeB|MgO. We find that the effective field is very sensitive to the thickness of the Ta and CoFeB layers. The effective field even changes its direction when the Ta layer thickness is varied, indicating that there are competing effects that contribute to the effective field generation. We discuss our results in light of the spin Hall effect and an effect due to Rashba-like Hamiltonian.
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