反強磁性／強磁性積層膜におけるスピン軌道トルク磁化反転

Spin-orbit torque induced switching in an antiferromagnet/ferromagnet heterostructure

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Spin-orbit torque (SOT), a torque generated by a current via the spin-orbit interaction, has drawn considerable attention from both fundamental and technological points of view. It was found that a magnetization can be reversed by SOT when one applies an in-plane current to a nonmagnet/ferromagnet heterostructure (NM/FM) [1-3], showing potential to be used for a three-terminal spintronics device [4]. To reverse a perpendicular magnetization, one needs to apply a magnetic field collinear with the current, which poses a technical challenge. To address this issue, here we investigate the SOT-induced switching in an antiferromagnet/ferromagnet (AFM/FM) heterostructure. Since antiferromagnetic materials are known to show exchange-bias effect, which manifests in an in-plane magnetic field, the magnetic-field-free switching is expected if the AFM/FM exhibits the SOT as in the case of NM/FM systems.

We develop a heterostructure consisting of an antiferromagnetic PtMn and a ferromagnetic Co/Ni multilayer. By tailoring the structure and process, we obtain the stacks where the Co/Ni layer has perpendicular easy axis and in-plane unidirectional anisotropy due to the exchange-bias effect. The films are processed into Hall devices and the magnetization state is measured through the anomalous Hall effect. SOT-induced switching properties are evaluated by applying in-plane current with various magnitudes. For the exchange-biased samples, we observe the magnetization switching by the current under zero magnetic fields. The current density required for switching is comparable to the values reported in previous studies [1-3]. These findings suggest that the AFM/FM system is a promising candidate for the SOT device. The observed switching property indicates that this system exhibits a SOT with the Slonczewski-like symmetry and its direction is the same with Pt/Co/AlO_X [1] and opposite to Ta/CoFeB/MgO [2,3].

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