MAR13-2012-020242

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Angular dependence of spin-orbit spin transfer torque[1]

KYUNG-JIN LEE, Department of Materials Science and Engineering, Korea University

Magnetocrystalline anisotropy arises from the modification of electron states by spin-orbit coupling and is determined by integrating over all occupied electron states. On the other hand, current-induced spin transfer torques arise from the changes in torques that arise from changes in electron populations in the presence of a current. In this respect, spin transfer torques caused by spin-orbit coupling can be interpreted as current-induced corrections to the magnetic anisotropy. From this perspective, we expect a close relationship between the magnetic anisotropy and spin-orbit spin torques. We theoretically study this relationship between magnetic anisotropy and spin-orbit spin torque for a ferromagnet subject to Rashba spin-orbit coupling. For a two-dimensional free-electron model, we find that Rashba spin-orbit coupling results in perpendicular magnetic anisotropy and field-like current-induced spin transfer torques. Both quantities acquire nontrivial angular dependence as the spin-orbit coupling becomes comparable to the s-d exchange interaction. This nontrivial angular dependence can be understood from Fermi surface distortion. In the limits where either the spin-orbit coupling or the s-d exchange interaction is much greater than the other, the Fermi surface consists of two concentric circles, but when they are comparable it distorts. These free-electron calculations are in qualitative agreement with ab initio calculations for Co|Pt bilayers, suggesting that the spin-orbit coupling at the interface is non-negligible in comparison to the s-d exchange interaction there. The nontrivial angular dependence of spin-orbit spin torque may be used as an indicator of strong interfacial spin-orbit coupling, because the spin-orbit spin torque that is induced by the spin Hall effect, has a simple $\sin\theta$ dependence where θ is the angle between the magnetization and the spin injected into a ferromagnet. This work has been done in collaboration with M. D. Stiles and P. M. Haney.

[1]This work is supported by NRF grant (2010-0023798).