MAR12-2011-005456

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Spin torque phenomena originating from the spin Hall effect: resonance, magnetic switching, and magnetic dynamics[1]

LUQIAO LIU, Cornell University

The spin Hall effect (SHE) generates a transverse spin current with the passage of a current through a non-ferromagnetic metal (NM) film. Quite different results have been obtained for the magnitude of this effect. Here I will discuss a new technique where, by applying an RF current to a NM/FM thin film bilayer, the spin current onto the FM layer can induce a spin torque ferromagnetic resonance (ST-FMR). This enables the determination of the SHE strength with precision and without the need to assume the values of unmeasured parameters. The large magnitude of the SHE that we have established in several types of NM is sufficient to reversibly switch the magnetic orientation of a FM layer and I will discuss two different implementations of this. In the first the FM layer has a perpendicular-to-plane magnetic moment at equilibrium and the SHE injected spins are orthogonal to the moment. The spin torque can overcome the anisotropy (coercive) field restoring torque, with the polarity of the current-induced switching being determined by the sign of a small external field applied along the current direction. In the second approach, the FM moment lies in plane and the spins injected by the SHE exert a negative damping just as in conventional ST switching of a spin valve or magnetic tunnel junction (MTJ). We have fabricated three-terminal devices that incorporate a MTJ and a SHE layer to induce in-plane reversal switching. The simple architecture of this three terminal device and the high efficiency of the SHE induced switching made it a promising technique for future memory and non-volatile logic applications. We have also used this three terminal device to demonstrate DC induced dynamics in the magnetic layer due to the SHE.

[1]With Chi-Feng Pai, O. J. Lee, T. J. Gudmundsen, D. C. Ralph and R. A. Buhrman