Domain wall motion by interfacial effects

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Manipulation of domain wall (DW) by spin-polarized current is essential for developing advanced storage class memory devices [1]. In bulk ferromagnets, conventional spin transfer torque is responsible for inducing DW motion along the electron flow [2]. However, in ultrathin magnetic heterostructures with large spin-orbit coupling and broken inversion symmetry (ultrathin magnetic layer with perpendicular anisotropy sandwiched between a heavy metal and insulating oxide layers), new mechanisms for magnetization manipulation emerge forcing DW to move with high efficiency in both directions (along or against electron flow) [3]. Key to the power efficient magnetization control is the large spin-orbit coupling of the heterostructure. The strong spin orbit-coupling constant of the heavy metal layer enables generation of large spin current via spin hall effect (SHE) that can impinge upon the magnetic layer to exert torque on the magnetic moments of the domain wall [4]. However, SHE only exerts torque in Neel wall configuration and moreover to move sequences of Neel walls with current in the same direction, neighboring DWs have to alternate its magnetization direction. This requires the formation of domain wall spiral via Dzyaloshinskii-Moriya interaction (DMI) [5]. Under this scenario, the domain wall moves very efficient and fast and its direction is defined by the signs of SHE and DMI, respectively [6].

In this talk, I will describe in detail the two spin-orbit coupling mechanisms, spin hall effect and Dzyaloshinskii-Moriya interaction, in connection with the manipulation of the chiral magnetic textures developed in magnetic heterostructure. Several experimental techniques recently used for the estimation of the sign and strength of SHE and DMI will be also discussed here.

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