# Micromagnetic analysis of the current driven domain wall motion along exchange-coupled ferromagnetic bi-layers

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Understanding and controlling the dynamics of domain walls (DWs) along ultrathin magnetic heterostructures consisting on a ferromagnetic (FM) strip sandwiched between a heavy metal (HM) and an oxide is nowadays the focus of intense research. These HM/FM/Oxide multilayers exhibit high perpendicular magnetocrystalline anisotropy, and the broken inversion symmetry at the interfaces promotes chiral Neel walls by the Dzyaloshinskii-Moriya interaction (DMI). These DWs can be efficiently driven by current pulses as due to the spin Hall effect (SHE) in the HM [1].

DW-based racetracks have been proposed as logic and memory devices. Their feasibility is particularly related to the speed of displacement of DWs within these devices. In particular, recent experiments [2] have demonstrated that DW speeds as high as 750m/s are achievable in multilayer systems composed of two FM strips antiferromagnetically coupled, with the use of a driving injected current.

The present work mimics by means of micromagnetic simulations the working conditions of such devices, showing the high importance of the antiferromagnetic coupling in their outstanding features. Systematic simulations of the two FM strips system have been performed considering either ferro-, antiferro- or no magnetic coupling between both strips. Simulations include the current driven dynamics of DWs either in presence or absence of in-plane applied fields. Results are in agreement with the experimental evidence [2], and give the key to interpret the underlying physical mechanisms that govern such a high-speed DW motion, which is found to be based on the dissimilarities between the ferromagnetic layers. Such dissimilarities include the different saturation magnetizations of both layers, and an interfacial DMI which is only required at the interface between the HM and the lower FM layer. Spin-orbit torques are only needed to act on the DWs in the lower FM layer, and DWs in the upper FM layer are dragged by the latter because of the interlayer exchange coupling (iEC). Our results indicate that in two-FM layers heterostructures with antiferromagnetic iEC, the DWs can be displaced even more efficiently and at much higher speeds if compared with the single-FM layer structure. This is due to a stabilization of the Néel DW configuration, and the exchange coupling torque that is directly proportional to the strength of the antiferromagnetic exchange coupling between the two FM layers.

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