Investigation of possible origins of the back-hopping effect in MTJs using macrospin simulations with STT obtained from a free electron model

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The back-hopping effect in spin-transfer torque (STT) driven magnetic tunnel junctions (MTJ) is a type of writing error that manifests itself in the hysteresis loop as a back-and-forth between the high-resistance (AP) and low-resistance (P) state for large voltages [1]. Recently, Devolder et al. performed time-resolved measurements [2] considering two potential origins: the non-monotonic voltage dependence of the dampinglike torque component in MTJs [3] that might result in an additional change of sign [4] and the destabilization of the reference layer by the STT [5]. They found their devices to undergo two switching events, P→AP followed by AP→P', with the latter relaxing back to AP when the voltage is cut off.

In our work, we couple a macrospin model to STT obtained from the non-equilibrium Green's function (NEGF) formalism [6] to investigate the proposed origins of the back-hopping effect in MTJs with a reference layer that is part of a synthetic anti-ferromagnet. We find that the destabilization of the references system results in an alternating magnetization reversal of the reference and free layer as seen in earlier theoretical studies [2] while the sign reversal of the dampinglike torque results in a second hysteresis loop.

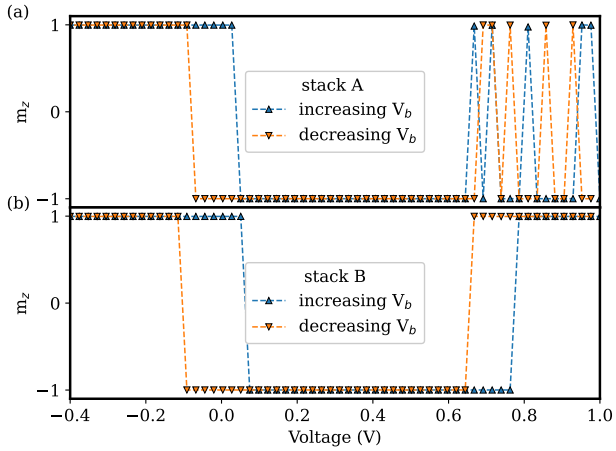

Figure 1: Simulated hysteresis loop for two sets of NEGF parameters, (a) the first leading to a large torque acting on the reference layer and (b) the second resulting in an additional sign-reversal of the dampinglike torque.

References

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