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Two-barrier stability that allows low-power operation in current-induced domain-wall motion

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Energy barrier appears in diverse systems in nature and its identification has long been received great interest. In particular, for magnetization reversal dynamics in ferromagnetic materials, the energy barrier gives the crucial device properties such as thermal stability (high thermal stability gives long life time) and threshold current (small threshold current allows low power consumption). Until now, there has been a severe dilemma that a low threshold current and high thermal stability cannot be satisfied simultaneously in systems with a single energy barrier (larger energy barrier for higher thermal stability inevitably leads to larger threshold current which causes higher power consumption). In this talk, we will give an evidence that this dilemma can be resolved in magnetic domain wall motion memory devices. By measuring the DW depinning time assisted by current as well as by magnetic field from a well-defined defect, we estimated the energy barriers quantitatively. It is found that two energy barriers, determined respectively by the magnetic-field and current, are definitely different. The energy barrier for current is much smaller and less scattered than that for magnetic field, which implies that two barriers are of intrinsic and extrinsic origin, respectively. Since the intrinsic energy barrier governs the threshold current whereas the extrinsic energy barrier assures the thermal stability, our work suggests that it is possible to obtain a low threshold current as maintaining a high thermal stability, which is not possible in conventional magnetic memory devices.

Reference

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