Enhanced current induced domain wall motion through interfacial engineering

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Racetrack memory which is a novel innately three-dimensional memory device promises a storage-class memory with the low cost per bit of magnetic disk drives but the high performance and reliability of conventional solid-state memories [1,2]. The data in racetrack memory is encoded as a pattern of magnetic domains along a portion of the nanowire which is composed of the perpendicular magnetized ferromagnetic layers such as Co/Ni and the heavy metal such as Pt thin film stack [3]. Current-induced domain wall (DW) motion in this perpendicular magnetized ferromagnet (FM)/heavy metal (HM) multilayer films has been intensively researched since its potential for realizing the memory devices with higher speed, compacity and low energy consumption. Driven by the spin-orbit torque generated from the spin-orbit coupling from the interfaces, the Néel type DW stabilized by the interfacial Dzyaloshinskii-Moriya interaction could move along the nanowire in response to sequences of current pulses with fast speed and fixed chirality [4,5]. The energy efficiency and highly scalable current-induced DW motion have been the main research focus for the realization of the racetrack memory devices.

Here, in this work, we demonstrate an enhanced current-induced DW motion through interfacial engineering by introducing atomic thin ‘dusting’ layers of 4d and 5d metal at the FM/HM interface in the magnetic stacks. We also apply this interfacial engineering approach to a synthetic antiferromagnetic structure which further increases the domain wall motion efficiency with considerably lower threshold current density which decreased by a factor of 3 and simultaneously substantially higher velocity which increased by a factor of 2. Significant modifications of magnetic properties could be realized with this novel technique with efficient manipulation of exchange coupling torque in SAF structure and more detailed inner correlations of interfacial interactions are discussed in this work.

References

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