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Using Exchange Bias to Control Magnetic Vortices[1]

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Spintronics has spurred the interest in patterned magnetic nanostructures both for fundamental reasons and due to their applications. Moreover, exchange bias (i.e., the exchange coupling between ferromagnetic, FM, and antiferromagnetic, AFM, materials) constitutes an essential part of many spintronics devices (e.g., read heads or MRAM). However, exchange bias in nanostructures has not been extensively studied [1]. We have investgated the magnetic behavior of exchange coupled ferromagnetic (Permalloy) – antiferromagnetic (IrMn) lithographed dots by magneto optic Kerr effect, magnetic force microscopy and micromagnetic simulations. We have recently demonstrated that vortex formation remains the reversal mode in these FM-AFM dots although the loops are shifted along the field axis [2]. In fact, the actual magnetization reversal mechanism (coherent rotation vs. vortex formation) is angle dependent [2] and can be controlled by varying the strength of the exchange bias or nucleation field [3]. Moreover, if the system is field cooled in an unsaturated state (i.e., using small fields) a new type of asymmetric hysteresis loop is found. This asymmetry is characterized by the appearance of curved, reversible, central sections in the hysteresis loops, with non-zero remanent magnetization [4]. The origin of the asymmetric loop shape is ascribed to the imprint [5] of displaced magnetic vortices in the AFM during the cooling process, which pin the vortex core away from the dot center.

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