Presented at MMM/Intermag 2016, January 14, 2016, San Diego

EC-06. Domain Wall Chirality in Exchange Spring Co/Pd Multilayers.

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The Dzyaloshinskii-Moriya Interaction (DMI) in materials with perpendicular magnetic anisotropy (PMA) has been of intense interest recently due to its critical role in controlling novel spin textures. Of particular interest is the nature of the DMI in Co/TM (TM=transition metal) multilayer films. Depending on the sign of the interaction, the domain wall chirality can be controlled [1]. We compare the magnetization reversal behavior and domain walls of two exchange spring $(Co/Pd)_{30}$ multilayer samples. Both samples have two different Co layer thicknesses (0.4 and 0.8 nm) and constant Pd thickness (1 nm). The first (two-phase) sample has the varying Co layers segregated in the stack with the bottom 15 layers having high perpendicular anisotropy 0.4 nm Co and the top having magnetically softer 0.8 nm Co. The second (alternating) sample interweaves the hard and soft PMA Co layers. Hysteresis loop and first order reversal curve (FORC) measurements for both samples show characteristics of the typical domain nucleation/propagation/annihilation process typical for Co/TM multilayers in this thickness regime. The FORC switching field distribution clearly shows easier domain nucleation for the two-phase sample. Using scanning electron microscopy with polarization analysis (SEMPA) we have investigated both the in-plane and out-of-plane domain topographies. At remanence (after saturation), both samples have the typical labyrinth domain pattern found in Co/TM multilayers with PMA [2]. The alternating sample has smaller domains on average and a small amount of in-plane magnetization. Superimposing the in-plane magnetization vector field shows that the in-plane contribution of the magnetization results from domain walls which point exclusively from the dark (down) domains to the light (up) domains. In contrast, the two-phase sample has significantly more in-plane magnetization. Interestingly, the in-plane vector field for this sample has domain walls with both wall chiralities, i.e. pointing from down to up AND from up to down. The chirality is a consequence of the DMI. The additional in-plane anisotropy from in the two-phase sample likely reduces the influence of the DMI and results in the mixed chirality Bloch Walls.

Work at UCD supported by NSF (DMR-1008791 and DMR-1543582). Work at NVE partially supported by NSF SBIR Grant IIP-1013982. Work at NIST supported through National Research Council Postdoctoral Fellowship program. [1] G. Chen, T. Ma, A. T. N'Diaye, H. Kwon, C. Won, Y. Wu, and A. K. Schmid, "Tailoring the chirality of magnetic domain walls by interface engineering.," *Nat. Commun.*, vol. 4, p. 2671, Jan. 2013. [2] J. Davies, O. Hellwig, E. Fullerton, G. Denbeaux, J. Kortright, and K. Liu, "Magnetization reversal of Co⁄Pt multilayers: Microscopic origin of high-field magnetic irreversibility," *Phys. Rev. B*, vol. 70, no. 22, p. 224434, Dec. 2004.