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Chiral Magnetic Domain Wall Structure in Epitaxial Multilayers

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In magnetic ultrathin films, the common textbook picture distinguishes two canonical types of DWs: Bloch walls for perpendicularly magnetized films and Néel walls for in-plane magnetized films. It still remains an open question whether the Bloch wall should be necessarily the only type of DWs in perpendicularly magnetized ultrathin films although it has been the textbook example for a long time. In ultrathin film, the inversion symmetry broken at interface will induce Dzyaloshinskii-Moriya interaction (DMI). In this talk, we will show that the DMI at interface will induce the chiral Néel type domain wall in perpendicularly magnetized films. The spin structure in magnetic domain wall was identified in real-space at room temperature by spin-polarized low energy electron microscopy (SPLEEM). The chiral Néel-type domain wall was identified in the magnetic stripe domain phase in Fe/Ni/Cu(001), and the chirality can switch from the right-hand cycloid in Fe/Ni/Cu(001) to the left-hand cycloid in Ni/Fe/Cu(001), which indicates that the chirality is caused by the DMI mainly located at the Fe/Ni interface [1]. The chiral domain wall structure can also be observed in $[Co/Ni]_n$ multilayer grown on Pt(111) and Ir(111)[2]. We found that Pt(111) substrate can induce right-handed chirality, whereas Ir(111) substrate can induce left-handed chirality, moreover, the chirality of the DW evolves from right-handed to left-handed in $[Co/Ni]_n$ grown on Ir/Pt(111) by changing Ir thickness, and the DW near the transition point shows non-chiral Bloch-type. Our results prove that domain wall chirality together with the sign and strength of the DMI can be tuned through the interface engineering, which may enable more possibility for designing of new spintronics devices. This work was collaborated with G. Chen, J. Zhu, A. T. N'Diaye, T. P. Ma, H.Y. Kwon, C. Won, Y. Huo, J. Li, A. K. Schmid.

[1] G. Chen, et al., Phys. Rev. Lett. 110, 177204 (2013).
[2] G. Chen, et al., Nature Communication, 4,2671(2013).