Magnetic Chiral Bubble Domain Observed in Fe/Co Crossed Wedge

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Magnetic bubble domain with specific chirality, such as skyrmion or meron, has attracted a lot of attention due to their novel properties, such as the topology-induced robust magnetization and the switchable polarity by external electric field or by low current density. These properties make them the promising candidates for the next generation spintronics. The Dzyaloshinskii-Moriya interaction was often responsible for the chiral spin textures discovered in the bulk materials with the B20 crystal structure[1,2] as well as in the heterostructures composed of the ferromagnetic (FM) ultrathin film and heavy metal (HM)[3-4]. Here, we propose this unique spin texture can be created by tailoring the coupled bilayer preferring Bloch- and Néel-type domain walls individually. A crossed wedge structure composed of Fe and Co ultrathin thin films were prepared for the demonstration. The domain evolution with coverage for individual layers and their related interaction was unambiguously imaged by photoemission electron microscopy with X-ray magnetic circular dichroism. The Co and Fe films, revealing same domain shape and domain contrast at the photon energy of their absorption edges, are ferromagnetically coupled. This coupling makes the Fe/Co bilayer behave as one single structure and results in the same critical thickness of spin-reorientation transition (SRT) occurring in Co and Fe/Co. Beyond SRT of Co and Fe films, we observed an additional transition for the in-plane magnetization. This transition occurs at the crossover from the Co dominated film to Fe dominated one in the coupled bilayer. A zoom-in image shows distinct magnetic bubble domains at the transition boundary. The formation of bubble domains is attributed to the competition between the Néel wall and Bloch wall. The relative spin configuration inside bubble domain was also proposed, rotating along the radial direction with the superposition of the spin arrangement of Bloch- and Néel wall. These observations provide an alternative route to generate the chiral bubble domain by merely tailoring the thickness of magnetic heterostructures.

References

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