Impact of Oxygen Adsorption on Spin Textures at Ultrathin Magnetic Interfaces: an XPEEM study

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Abstract

The study of non-collinear spin structures, originated from Dzyaloshinskii-Moriya interaction (DMI), has attracted much attention. The chiral textures have been recently studied by X-ray magnetic circular dichroism (XMCD) based photoemission electron microscopy (XPEEM) in MgO/Co/Pt, demonstrating the possibilities of investigating chiral spin structures by XPEEM [1]. In addition, an imaging of magnetic stripe domains in epitaxial Fe/Ni bilayers on Cu(001) has suggested the existence of Néel-type chiral domain walls with a fixed chirality, meaning even a weak DMI can stabilize a non-collinear spin structure [2]. Recently, it has been predicted that the DMI can be manipulated by the adsorption of oxygen atoms due to the hybridization of transition metals and the oxygen [3]. However, at this moment there is still no direct experimental proof.

Here we report that by using XPEEM with XMCD contrast at BL05B2 end-station at the Taiwan Light Source, a microscopic insight on how the oxygen adsorption modulates the spin reorientation transition (SRT) of a Fe/Ni bilayer on Cu(100) is provided, and the evolution of the featured stripe-domains across SRT at different thicknesses of oxygen coverage is visualized [4]. The change of SRT thickness towards thinner Fe films due to the decrease of magnetocrystalline anisotropy by oxygen is visualized by the shifting of stripe-domain region. The change of the width of stripe domains by the oxygen adsorption is then discussed with the help of micromagnetic simulations. It is found in experiment that the averaged domain width is increased when the thickness of oxygen passivation is increased. It could be an evidence that the DMI-magnitude is decreased when the oxygen atoms are passivated on top of the Fe surface, which is supported by first-principle calculation [3] and the micromagnetic simulations. Realizing the control of the DMI in ultrathin metal films is of great importance in the surface/interface physics and it will pave the way towards the design of chiral magnetic properties through interface engineering.

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Reference:

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