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Orbital magnetic moment of heavy metals in Co-heavy metal heterostructures studied by x-ray magnetic circular dichroism

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Dzyaloshinskii-Moriya interaction (DMI) [1] is considered to play an essential role in stabilizing Néel type domain walls (DW) in ferromagnet (FM)/5d heavy metal (HM) heterostructrues. Such a Néel type DW could be moved by electric current due to the existence of spin-orbit torque, making FM/HM heterostructures as a promising candidate for the future electric control of magnetic memory devices. However, the origin of such interfacial DMI is still unclear, becoming a large obstacle to design practical devices. It has been considered that the microscopic origin of interfacial DMI may be attributed to the anisotropy of orbital magnetic moment and the magnetic dipole moment of ferromagnetic metal. However, it has also been predicted theoretically that the HM in FM/HM heterostructrues has orbital moment anisotropy, which may be correlated with the sign of DMI directly [2].

In the present study, the orbital magnetic moment of HM in Co/HM (HM = Hf, Ta, W and Pt) heterostructures was studied by x-ray magnetic circular dichroism (XMCD) in order to investigate its correlation with DMI. The Pt $L_{2,3}$-edge XMCD spectra of Co/Pt heterostructure under different magnetization configuration are shown in Fig. 1, supporting the fact that Co could induce magnetism in Pt by proximity effect. However, no clear XMCD are observed at the Hf, Ta, and W $L_{2,3}$ edges of Co/Hf, Co/Ta and Co/W. This suggests that interfacial DMI of Co/HM systems is mainly governed by the magnetic properties of Co.

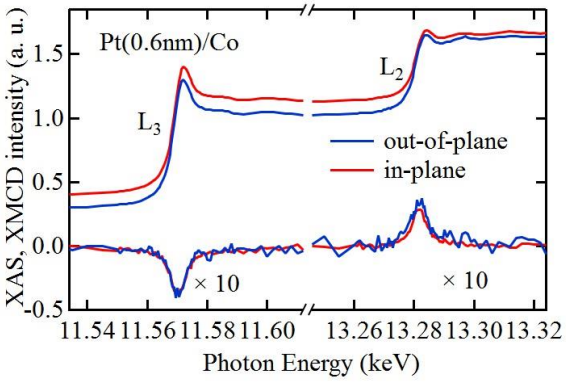

Fig. 1 Pt $L_{2,3}$-edge XAS and XMCD spectra of Co/Pt heterostructures under different magnetization configuration.

Reference

[1] I. E. Dzyaloshinskii, *JETP* **5 (6)**, 1259(1957); T. Moriya, *Phys. Rev.* **120**, 91 (1960).

[2] K. Yamamoto *et al.*, *AIP Adv.* **7**, 056302 (2017).

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