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Surface and interface magnetic anisotropy of Co/Pd (111)

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Introduction

The surface and interface properties of magnetic thin films are thought to be important factor of their magnetism since, compared to a bulk sample, they have large proportion in a film. In Co/Pd system, many studies suggest that interface layer favors perpendicular magnetic anisotropy (PMA) and cause PMA of a whole film. But few studies perform direct observation of the interface.

We have investigated the depth-resolved X-ray magnetic circular dichroism (XMCD) [1]. Surface, interface and inner layer components of XMCD signals were separately extracted.

Experiment

The experiments were carried out at BL-7A and 11A. Co was deposited on a clean and ordered Pd(111) surface at room temperature by electron bombardment heating of a Co rod. Pd was deposited on the Co film in the same way and Pd/Co/Pd sandwich film was prepared. The film thickness is evaluated from spectrum edge jump.

From depth-resolved XMCD experiments, several spectra with different probing depths are obtained. Spectral components of the surface layer and rest inner layers are extracted from the obtained data. A Pd/Co/Pd film was used to extract interface spectrum. Further information on the method is described elsewhere [1].

Results and discussion

Surface and interface orbital magnetic moments are estimated from the extracted spectra by using the sum rule [2]. Since the orbital magnetic moment is considered to be the origin of magnetic anisotropy, it can be used in discussion as shown below.

The estimated orbital moments are shown in Fig.1. In the all thicknesses, the surface layer has large orbital moment compared to the inner layers. Since their differences are larger in films with in-plane magnetization, the surface layer favors in-plane magnetization.

Results of the interface layer are clearer. In PMA samples, the interface moment is larger than inner layer one, and an opposite inclination is fond in the case of in-plane magnetization. Interface layer thus favors perpendicular magnetization. 3ML sample is not consistent with the others, but in such a thin film, the interface between Co film and substrate cannot be ignored and the assumption used in this study is not appropriate.

Conclusion

Surface and interface magnetic orbital moment of Co/Pd films and Pd/Co/Pd films are estimated with depth-resolved XMCD. The surface favors in-plane magnetization, while the interface favors perpendicular magnetization. These cause PMA in the thin film region.

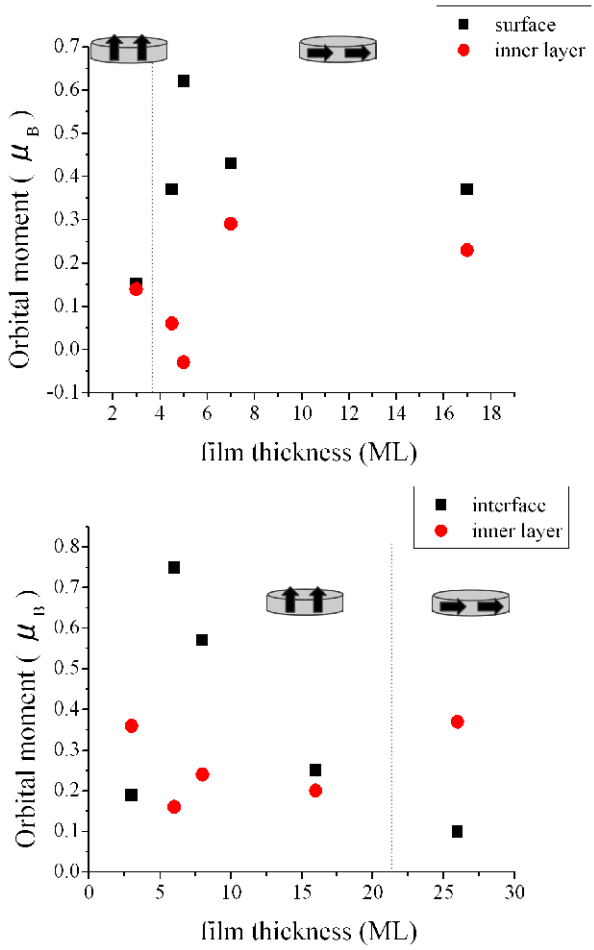

Figure.1 Orbital magnetic moment of the surface and interface layer compared to respective inner layers.

References

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