19A/1999G010

Spin-dependent interface electronic states of fcc Fe/Co(001)

Akio KIMURA[1*], Nozomu KAMAKURA[1], Kei HAYASHI[1],
Ayumi HARASAWA[1], and Akito KAKIZAKI[1]
[1]Tsukuba Branch of ISSP, The University of Tokyo, Tsukuba, Ibaraki 305-0801, Japan

Fe thin film on noble metal surface shows a variety of magnetic properties and many experimental studies have been devoted to clarifying the relationship between magnetism and electronic structure. It is known that the Fe thin film grown on Cu(001) forms a face-centered tetragonal (fct) structure with film thickness less than 5 monolayers (ML) and fcc structure with film thickness more than 5ML [1]. The ferromagnetism of fct Fe/Cu(001) has been explained by the large distance between Fe atoms along the direction normal to the surface [1]. A very similar structural character has been found for the room temperature growth of the Fe film on fcc Co(001) surface by low energy electron diffraction (LEED), and from analogy with the Cu case it has been suggested that the growth is very similar, in particular the presence of fct and fcc Fe below and above 5ML, respectively [2]. The magnetic properties are a little different from Fe/Cu(001) in the thickness range 5-11ML. O'Brien et al. have observed the small X-ray magnetic circular dichroism (XMCD) signal in fcc/Co(001) in the 5-11ML range at R.T. [2], To clarify the spin dependent surface and interface electronic states of fct and fcc Fe/Co(001), we have carried out the spin polarized photoemission spectroscopy of Fe and Co 3p core level.

The experiment was done at BL-19A, which is equipped with an angle-resolved spectrometer and a Mott polarimeter for photoelectron spin analysis. Base pressure of the ultrahigh-vacuum system was 1×10^{-10}Torr. The direction of the sample magnetization was <110>, which was parallel to the sample surface. The photoelectrons emitted normal to the sample surface were collected with the angle of incident light at 20° at R.T..

Fig.1 shows the spin resolved Fe 3p and Co 3p core level photoemission spectra of 0.9ML Fe/Co(001). The peak structure of the minority spin photoelectron spectrum is located at lower binding energy than that of the majority spin spectrum for both of the Fe and Co 3p core levels. It is known that the energy splitting between the majority and minority spin spectra is caused by the exchange coupling between the core hole spin and the 3d electron spin, which is related to the 3d spin magnetic moment. The result suggests that the Fe 3d derived spin magnetic moment is aligned parallel to that of the Co 3d state. It is evaluated that the energy splitting of the Fe 3p core level photoemission spectra is 0.8eV, which is larger than the reported value of the bcc Fe (~0.5eV) [3]. This large exchange splitting is consistent with the large exchange splitting in the Δ_5 band measured by the spin and angle resolved photoemission spectroscopy [4]. The corresponding energy splitting of 6.6ML Fe/Co(001) is found to be much smaller (0.25eV). This is consistent with the result of the small XMCD asymmetry for the 5-11ML fcc Fe/Co(001) observed by O'Brien et al. In an analogical way to the case of Fe/Cu(001), we speculate that the topmost 2 layers show the ferromagnetism, whereas the bulk layers (below top 2 layers) show no net magnetic moment due to the formation of the antiferromagnetic or para-magnetic structure. This speculation is supported by the reduced energy splitting but finite spin polarization still found for 6.6ML Fe/Co(001).

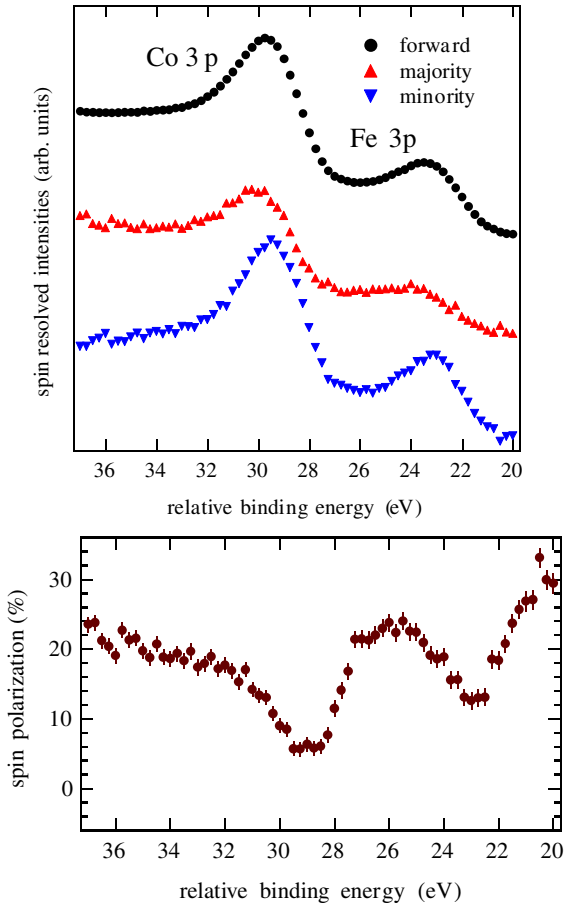

Fig.1 (a) Spin polarized Fe 3p and Co 3p photoemission spectra (a) and its spin polarization (b) of 0.9ML Fe/Co(001).

References

[1] W. Wuttig et al., Surf. Sci. 331-333 (1995) 659.
[2] W. L. O'Brien et al, Surf. Sci. 334 (1995) 10.
[3] B. Sinkovic et al., Phys. Rev. Lett. 65 (1990) 1647.
[4] N. Kamakura et al., J. Electron Spectrosc. Relat. Phenom. 92 (1998) 45.

* akiok@hiroshima-u.ac.jp