Spin polarized valence band photoemission from non-magnetic Cu(001)

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We have performed a spin- and angle- resolved photoemission spectroscopy (SARPES) of non-magnetic Cu(001) surface. It is known that the spin polarized electrons can be obtained from the non-magnetic surface if the circularly- or linearly- polarized light excites the photoelectron. In this report, we will show the SARPES spectra from Cu(001) surface excited by the p-polarized synchrotron radiation. The mechanism related to the yield of the spin-polarized photoelectron can be treated by the simple symmetry consideration. The finite spin polarization along the perpendicular direction to the measurement plane is expected when the photoelectron is excited by the p-polarized light [1].

The SARPES measurement was carried out at BL-19A. The angle of the incident undulator radiation is 20° from the surface normal. The perpendicular component to the mirror plane of the spin polarization was observed by the Mott polarimeter equipped with the hemispherical electron analyzer. The instrumental asymmetry was eliminated using the magnetized fcc cobalt thin film evaporated on Cu(001).

Fig.1 (a) shows the SARPES spectra of Cu(001) taken hν=45eV, which corresponds to Γ point in the fcc Brillouin zone. The two peak structures observed at the binding energies (E_B) of 2.6 and 3.3eV in the SARPES spectra can be assigned to the states with Δ_1 and Δ_5 spatial symmetries. It is noticed that the Δ_1 symmetry state has the negative spin polarization, whereas the Δ_5 symmetry state has the positive spin polarization. Fig.1 (b) shows the SARPES spectra taken at hν=69eV, corresponding to the middle point of the Δ line. It is found that the structure with the positive spin polarization is located at the lower E_B and the structure with the negative spin polarization is at the higher E_B and they are closer in energy compared to those of the spectra taken at hν=45eV. The relativistic band structure calculation shows that the Δ_5 and Δ_1 symmetry states are closer at the middle point of the Δ line and are strongly hybridized in the presence of the spin-orbit interaction [2]. The calculation also shows that the dominant characters of the states at the lower and higher binding energies are Δ_5 and Δ_1 at this middle k point, respectively, which are opposite to the case at the Γ point [2]. This is consistent with the change of the spin polarization in the SARPES measurements taken at the different excitation energies.

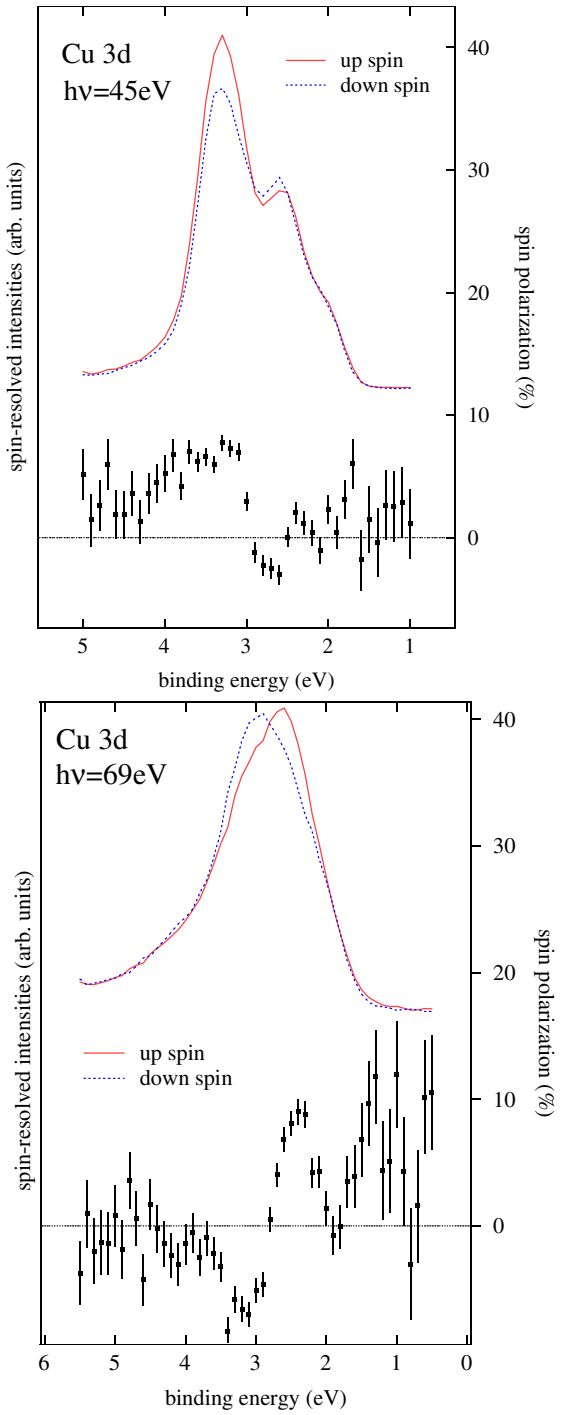

Fig.1 SARPES spectra of Cu(001) taken at hν=45eV (a) and hν=69eV (b).

References

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