Angle-resolved photoemission studies of a surface state on Cu(104) surface

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Introduction

In the last few years, several articles have been devoted to study of the influence of steps on surface state [1]. At the Cu(001) surface, the M-point Tamm state is observed as a very sharp peak [2]. At the stepped surface, the surface state band shifts to higher binding energy and the dispersion curve is reduced in the bandwidth. On a vicinal surface, there are periodical rows of monoatomic steps. The surface states are modified by the step super structure. We report a superlattice band structure of the surface state observed for the Cu(104) surface**.**

Experimental

The angle-resolved photoemission measurements were made on BL-18A with an ADES-500 spectrometer. The total energy resolution was 100 meV. The clean Cu(104) surface was prepared by repeated Ar^+ sputtering and annealing cycles. We observed LEED patterns with sharp double spots, consistent with a regularly stepped surface structure. The degree of splitting and the incident energy dependence of the LEED pattern were those expected from simple crystallographic considerations for Cu(104) surface [3]. The electric vector of incident light and the direction of detecting photoelectrons were in a plane perpendicular to the step direction.

Results and Discussion

Fig.1 shows a series of angle-resolved energy distribution curves for various polar angles measured in the downhill direction with photon energy 20 eV. A weak peak indicated by tic mark is observed above d-band maximum. Fig.2 shows measured band dispersion of the state for photon energies 16, 20 and 25 eV. The dispersion is independent of photon energy providing confirmation of the surface state.

The M-point Tamm surface state on Cu(001) surface is associated with a gap in the Cu bulk band structure at the X point [2]. The projection of the appropriate X point onto Cu(104) lies at $k_{//}=1.27A^{-1}$. The maximum of the dispersion curve of Fig.2 lies on this point. We can say that the state observed on the Cu(104) surface is the Tamm surface state which is confined to the terrace separated by steps. We get the band shift of about 170 meV (cf. -1.8 eV at M-point on Cu(001) surface), which arise from confinement of the surface state wave function to the terrace [2]. The bandwidth is reduced to about 80 meV.

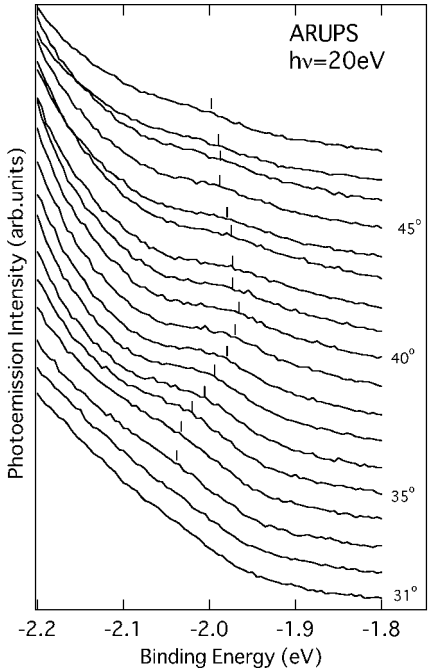

Fig. 1 Photoelectorin energy distribution curves taken from Cu(104) surface.

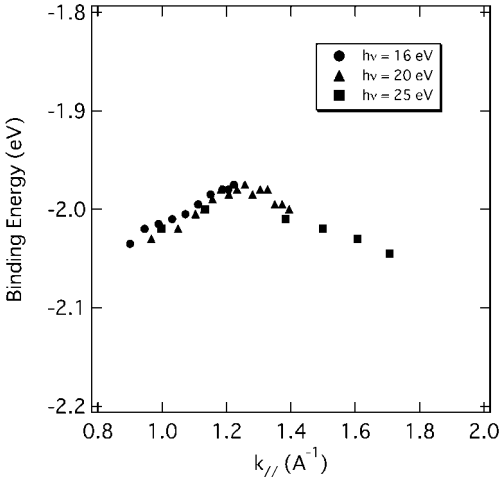

Fig. 2 Dispersion of the Tamm surface state on Cu(104)

References

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