

Electronic states of K/HOPG

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Introduction

Graphite is a quasi-two-dimensional semimetal consisting of the layered graphene sheets, which are bonded by weak van der Waals interaction. When alkali metal is doped into graphite, alkali metal can be regarded as a donor. Thus, adsorption of alkali metal on graphite leads to the charge transfer from alkali metal to graphite at the surface. Here, band dispersion of K/HOPG around K-point has been studied by angle resolved photoemission spectroscopy (ARPES). Since the density of states near E_F comes from π band around the Brillouin zone corner, the study on behaviour of the π band around the zone corner with K adsorption is expected to bring about a better understanding of the bonding character between alkali metal and graphite. By measuring the ARPES spectra in plane, thus, change in the dispersion of π band with K adsorption is investigated.

Experimental

Photoemission experiments were performed at an undulator beamline BL-28A of the Photon Factory (PF) in KEK. We have used the photon energy of $h\nu = 52$ eV for the ARPES experiments. The ARPES spectra at the zone corner using $h\nu = 52$ eV probe the band dispersion at K-point in three-dimensional Brillouin zone.

Results and discussion

Figures 1 and 2 show ARPES spectra for HOPG and K/HOPG around K-point. The π band nearly reaching to E_F at K-point in Fig. 1 shifts toward higher binding energies by the K adsorption in Fig. 2, indicating charge

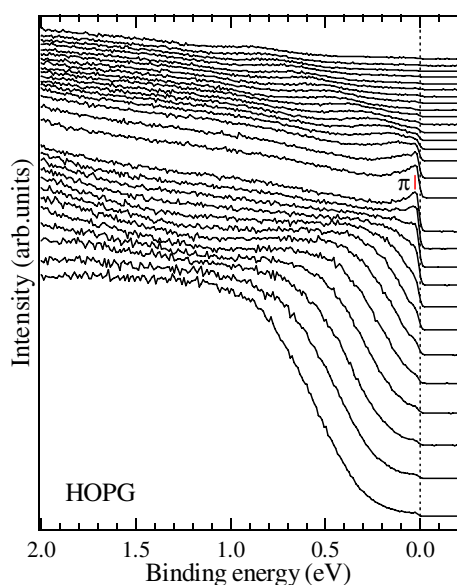


Figure 1. ARPES spectra around K-point for HOPG measured with $h\nu = 52$ eV.

transfer from K to graphite. As a result, the top of the π band is located at energy position marked by A in Fig. 2 and the dispersion from peak A toward higher binding energies is observed. In the band structure of graphite, the π and π^* bands degenerate at K-point and disperse toward higher and lower binding energies in plane, respectively. However, dispersion from peak A (the top of π band) toward lower binding energies is not observed in the ARPES of Fig. 2, and there is a dip just above the π band. Therefore, peak B on low binding energy side of the dip is assigned to the bottom of π^* band, showing lift of the degeneracy of π and π^* bands at K-point by the K adsorption. This behaviour is consistent with the calculation for the two graphite layers under applying electric field along c-axis[1]. There, the electric field, which breaks the symmetry along the c-axis, leads to lift of the degeneracy and opening of the gap between the π and π^* bands, while the present case involves the energy shift of the π and π^* bands on high binding energy side corresponding to increase in the carrier density. The consistency is understood by the quasi-two-dimensionality of graphite.

References

[1] C. L. Lu, C. P. Chang, Y. C. Huang, J. M. Lu, C. C. Hwang, and M. F. Lin, *J. Phys.: Condens. Matter* **18**, 5849 (2006).

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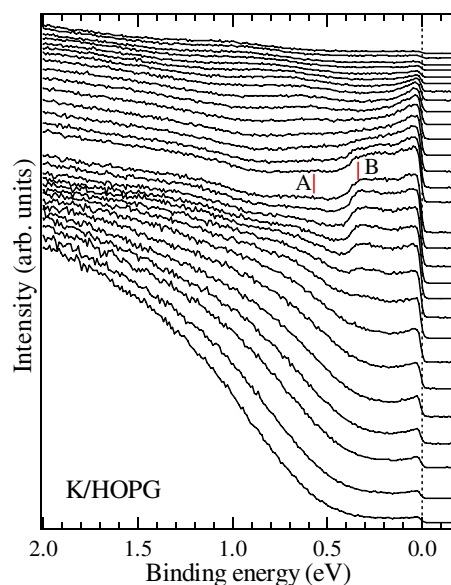


Figure 2. ARPES spectra around K-point for K/HOPG measured with $h\nu = 52$ eV.