Angle-resolved photoemission spectroscopy study of epitaxial graphene on Cu(111)

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Interactions between a substrate and graphene have been a major interest in graphene research field, because it could alter the electronic properties of graphene, such as carrier concentration, band gap, and mobility. The interactions are induced by a bonding or stacking between them. Especially, the substrates used for graphene growth by chemical vapor deposition (CVD) have received huge attention to investigate the role of catalytic behavior. Ni substrate was firstly used for CVD graphene growth, but it showed difficulties in layer thickness control. Cu foil was suggested as a substrate for the growth of monolayer graphene with the self-limiting process, since it has lower carbon solubility than those of Ni and Fe.[1] Recently, scanning tunneling microscopy study revealed the multi-domain graphene growth on Cu(111) surface,[2] which is in contrast to the graphene growth on Ni(111). The various domain formations on Cu foil by CVD growth were also reported, in which the domain width can be varied by growth condition.[3] However, the band structure of multi-domain graphene on Cu substrate has not been yet reported despite its importance.

In this study, we investigated the band structure of epitaxial graphene on Cu(111) surface using angle-resolved photoemission spectroscopy (ARPES). The experiment was performed at the beamline 3A2 of the Pohang Light Source in Korea. Graphene was grown on Cu(111) surface in an ultra-high vacuum chamber connected to the ARPES chamber equipped with R4000 analyzer (VG-Scienta) by introducing C_2H_2 at 1250 K. The band structure of graphene was observed at the K point after C_2H_2 dosing of 10 L (1 L = $1x10^{-6}$ Torr for 1 sec.). At the same time, the Shockley surface state of Cu(111) at Γ was split into two states. The one appeared at the lower binding energy side exhibited the charge transfer from Cu surface to graphene, resulting in the band structure of graphene with n-type doping. As increasing the dose of C_2H_2, several linear bands of graphene were observed as expected from STM results.[2] Every graphene band showed a similar n-type doping character regardless their orientations, and the band images were not changed except their intensity until the Shockley state was emerged by one with p-type doping character, which implies the formation of monolayer graphene on Cu(111) surface. We would like to discuss more detail about the results on site.

References

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Figure

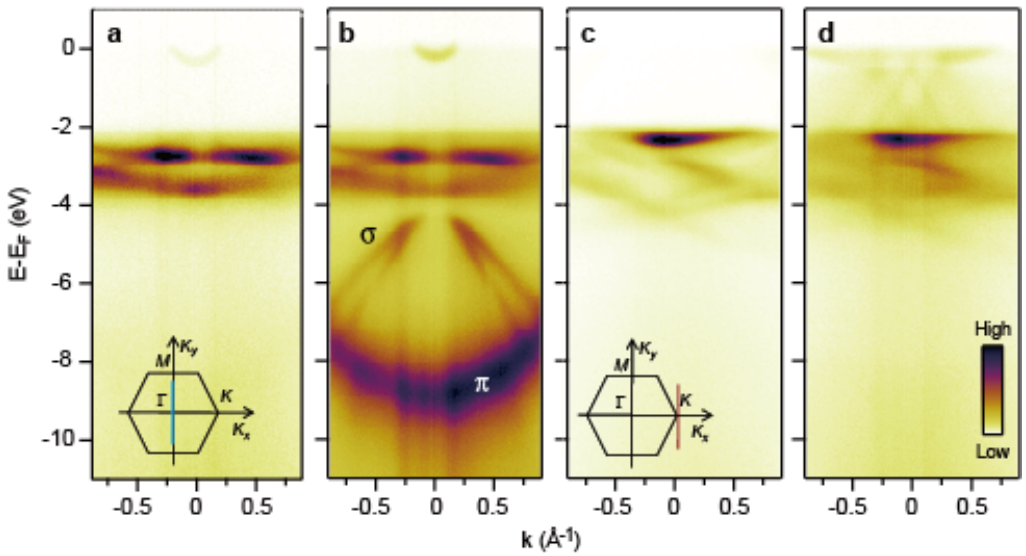

Fig. 1: Band structures of Cu(111) surface around the (a, b) Γ and (c, d) K points before and after graphene growth, respectively.