NANOSCALE ANALYSIS OF ELECTRONIC STATES OF GRAPHENE BY USING 3D NANO-ESCA

–GRAPHENE ON MICROSTRUCTURED SI SUBSTRATE TOWARD MULTIFUNCTIONAL DEVICES-

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We have used 3D nano-ESCA as the powerful means in material designation [1] and device fabrication [2, 3]. For the study on the device operation mechanism, we have succeeded in carrying out operando observation of graphene transistors.

In parallel with the device mechanism work, material designation which extract a full potential of graphene should be done. One of the effective methods is to modulate the band structure of graphene, which is susceptible to the stacking of graphene layers. For this purpose, we have proposed the novel method, namely 3D-GOS, to microscopically graphene's band structure by controlling the crystallographic orientation of 3C-SiC thin films on a microstructured Si(100) substrate, as schematically shown in Fig. 1 [3].

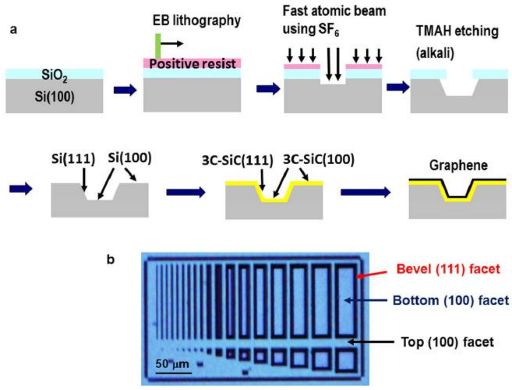

Figure 1 (a) Schematics of 3D-GOS. (b) Optical micrograph of 3D-GOS.

For the microscopic investigation of interface bonding between graphene and 3C-SiC(111) and 3C-SiC(100) microfacets, cross-sectional transmission electron microscopy (X-TEM) and 3D nano-ESCA were used, as shown in Fig. 2. As a result, it is clearly demonstrated that the orientation of 3C-SiC microfacets critically determines the interface structure, i.e. presence vs. absence of the buffer layer which can be viewed as the precursor of the graphene.

Furthermore, we have carried out micro-LEED analysis of 3D-GOS, and found that the graphene stacking depends on the interface bonding. Finally, the Raman microscopy measurements reveal that the graphene band structure varies, depending on the crystallographic orientation of 3C-SiC microfacets.

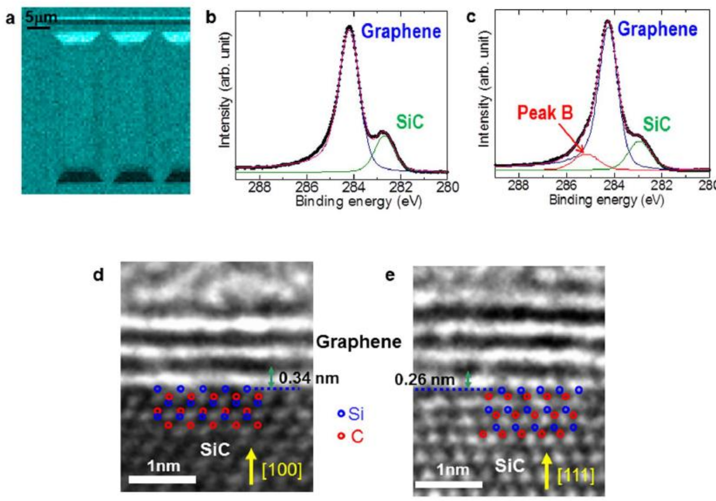

Figure 2 (a) C1s intensity mapping of 3D-GOS. (b,c) C1s core level spectra of graphene on 3C-SiC(100) and 3C-SiC(111) thin films, respectively. (d,e) X-TEM images of graphene on 3C-SiC(100) and 3C-SiC(111) thin films, respectively.

Thus, we establish the 3D-GOS method to tune microscopically band structure by Si(C) microfacets through stacking of graphene.

REFERENCES

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