Growth of hetero-epitaxial graphene and 2D materials on SiC

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The graphene/SiC system is one of the ideal platforms for two-dimensional materials research because it has an atomically flat surface and allows us the production of large-area, single-orientation graphene. Using this graphene/SiC system, we can modulate the electronic state of graphene and fabricate new two-dimensional materials by introducing other substances. In this presentation, I will report on the fabrication of two-dimensional iron oxide with a structure not present in bulk at the graphene/SiC interface [1], and on graphene/NbC/SiC grown by thermal decomposition of NbC deposited on SiC.

For 2D-FeO growth, a buffer layer with a structure almost identical to graphene was formed on SiC, and then iron with a thickness of approximately 4 nm was deposited on top of it. The sample was exposed to air, and then re-introduced into a vacuum chamber and heated at 660ºC. Figure 1 shows a high-angle annular dark-field scanning transmission electron microscope (HAADF-STEM) image of the obtained sample. Three layers of bright spots are observed at the graphene/SiC interface. Our analysis revealed that these bright spots are 2D-FeO with a structure which was not present in nature.

On the other hand, when a thin NbC film with a thickness of approximately 10 nm was deposited on a SiC(000-1) substrate using pulsed laser deposition and then heated, graphene was formed on its surface. Angle-resolved photoemission spectroscopy measurements of the graphene/NbC/SiC sample revealed a linear band with a Dirac energy of about -0.4 eV at the K point of graphene in reciprocal space, as well as a Dirac-like band at about -3.0 eV. First-principles band structure calculation for graphene/NbC suggested that the former band is due to the uppermost graphene layer, while the latter is due to a carbon layer bonded to Nb on the surface of NbC. This is the similar situation to the electronic state of the buffer layer on the SiC(0001) surface.

In addition to these results, I will also present results for the fabrication of graphene/WC/SiC by thermal decomposition of WC deposited on SiC, WSe_2/WC/SiC by heating WC/SiC in a Se atmosphere, and WSe_2 on graphene/SiC using chemical vapor deposition [2].

References:
[1] R. Sakakibara, WN, et al., Small Methods 0, e01889 (2026).
[2] R. Sakakibara, WN, et al.. Nano Lett. 25, 12851 (2025).

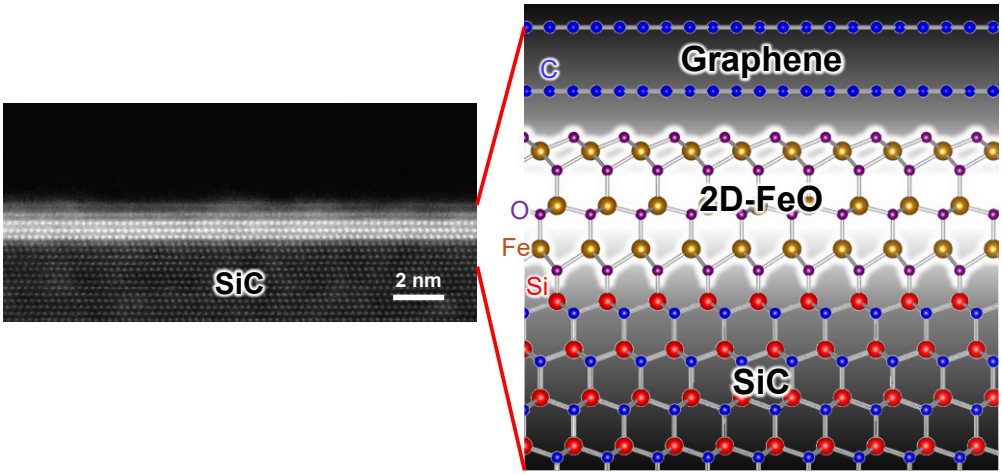

Fig. 1: HAADF-STEM image of graphene/2D-FeO/SiC together with its structural model.