Fabrication of wide terraces on SiC (0001) for step-free and pit-free monolayer graphene growth

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BACKGROUND>

High quality epitaxial graphene has been formed by thermal decomposition of SiC due to sublimation of Si atoms during heat treatment. However, surface steps on SiC substrates prevent graphene from continuously growing across SiC surfaces. Therefore, step-free SiC surfaces were needed for preparing uniform graphene. In addition the formation of pits on terraces prevents graphene from being formed uniformly. How to produce graphene without pit is still a big issue for this method.

EXPERIMENTAL>

The SiC substrates are annealed at various temperatures and at various pressures of argon (Ar) atmosphere, and the processes of annealing the SiC substrates are investigated by in situ scanning tunneling microscope (STM) to reveal the most appropriate annealing condition for forming wide terraces and pit-free graphene on SiC.

FEATURES AND ORIGINALITY>

Knowledge on growth process of graphene on SiC is still limited, because of the difficulty to in-situ study such annealing system including high temperature and gas atmosphere. In this study, we modified an ultra-high-vacuum STM equipment to make it possible to anneal samples repeatedly in an atmosphere and observe surface changes at various stages without exposure to the air.

RESULTS>

Firstly, we observed that terraces on SiC surfaces keep growing due to the step bunching before the forming of graphene layers, and found that the largest increasing rate of terrace widths was obtained at 1400℃. Then we prepared SiC samples with about 5-μm-wide terraces by annealing substrates at 1400℃ for 3 hours in 1-atm Ar atmosphere. After that, in order to avoid pit formation during graphene growth, we aim to grow graphene only from the step edges by controlling the graphene growth temperature. Figure (a) shows an AFM phase image of graphene grown on a 4-μm-wide of SiC by annealing sample at 1550℃ for 20min in 1-atm of Ar atmosphere. Monolayer graphene is formed from the step edges and extending continuously crossing the terraces without steps or pits (figure (b)). However, remaining of stripped buffer layers is still a problem for the graphene growth from step edges.

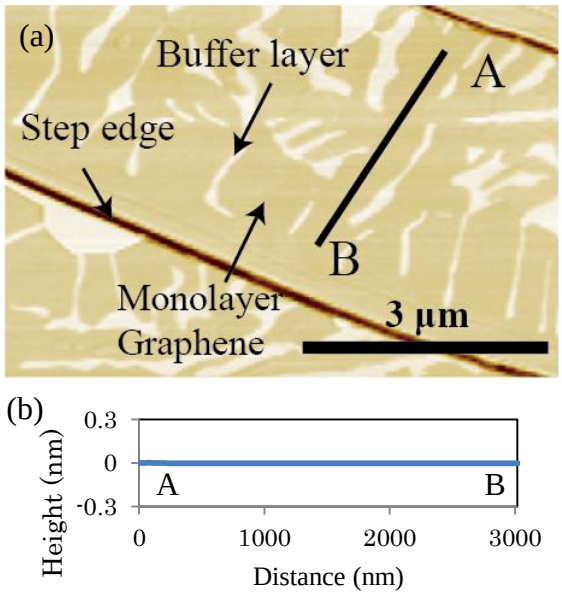

Figure. (a) AFM phase image of graphene grown on 4-μm-wide terrace of SiC surface. (b) Height profile of graphene extending over the terrace.

KEYWORDS>

Graphene, SiC, step-free, pit-free.