

The correlation between the growth temperature of graphene deposited on the 3C-SiC/Si template substrates and the quality of the obtained layers

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Abstract

Epitaxial graphene is a new material composed of one or more two-dimensional sheets of carbon atoms in which each carbon atom is covalently bound to its 3 neighbors (sp² bonds) to form a honeycomb structure. It can be grown on many silicon carbide polytypes such as 6H [1], 4H [2] and 3C [3]. However, the high cost of hexagonal SiC substrates is a major hindrance to the application of graphene on SiC. Moreover, silicon carbide substrates have a limited diameter (up to 6"), unlike silicon substrates, the diameter of which is even up to 18". To overcome all these problems we have been investigating the use of a 3C-SiC thin carbonization layer on silicon substrates as a template substrate for graphene epitaxy. Such a graphene layer offers excellent potential for obtaining graphene films on large-area silicon wafers. Moreover, such an epitaxial structure is compatible with silicon technology.

Firstly, the deposition of the 3C-SiC carbonization layer on the silicon substrate has to be performed using a resistively heated hot-wall Chemical Vapor Deposition reactor. The 3C-SiC carbonization layer is formed while silicon atoms which out-diffuse from the substrate react with carbon atoms from the precursor in appropriate growth conditions. Growth of the SiC layer is self-regulated due to the limitation of Si out-diffusion and carbon-in-diffusion at a given temperature [4]. 3C-SiC formed on the Si substrate is not used as a layer that is self-converted into graphene by sublimation but rather as a template for graphene growth. In the next step, the graphene layer on the silicon carbide substrate is obtained.

To sum up, we could divide the growth process into two parts. At first, there is growth of the 3C-SiC carbonization layer and subsequently the deposition of graphene. We investigate the influence of the process growth temperature (1050°C, 1200°C, 1250°C and 1300°C) of the graphene layer on its crystalline quality. From our experiments, an appropriate value of the temperature of the deposition of the graphene layer is 1250°C.

Each of the sets of the samples grown with the graphene layer in different thermal conditions is subject to characterization using two methods. Atomic Force Microscopy measurements allow determination of the influence of the process temperature on the morphology of the surface of graphene. Based on Raman Spectroscopy measurements we assess the quality of the obtained graphene layers.

References

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