Multilayer graphene on SiC(000-1): thermal decomposition versus chemical vapor deposition

A. Al-Temimy[1], D. Convertino[1,2], M. Al-Ahmad[3], H. Benia[3], U. Starke[3], C. Coletti[1]

[1] Center for Nanotechnology Innovation @ NEST, Istituto Italiano di Tecnologia, Piazza San Silvestro 12, 56127 Pisa, Italy
[2] Laboratorio NEST – Scuola Normale Superiore, and Istituto Nanoscienze – CNR, Piazza San Silvestro 12, 56127 Pisa, Italy
[3] Max-Planck Institute for Solid State Research, Heisenbergstr. 1, 70569 Stuttgart, Germany

camilla.coletti@iit.it

Epitaxial growth of graphene by thermal decomposition of silicon carbide (SiC) is a classical approach to obtain large-area continuous films directly on a semi-conducting substrate [1, 2]. The two different basal planes of the hexagonal SiC polytypes, i.e., SiC(0001) (Si-face) and SiC (000-1) (C-face), show significantly different growth modes for graphene. In particular, the graphene layers obtained on the C-face lack a defined azimuthal orientation (i.e., turbostratic graphene) so that each layer behaves as an isolated layer and is electronically decoupled from the neighboring ones. For this reason, on this type of graphene, remarkable carrier mobilities have been measured [3]. Thickness control for graphene grown by means of thermal decomposition of SiC(000-1) is quite difficult to achieve. Recently, we have developed a chemical vapor deposition (CVD) approach that allows to synthesize graphene on SiC(000-1) while finely controlling the number of grown layers [4].

This work aims at comparing the structural, chemical and electronic properties of few-layer graphene grown on the C-face of SiC by using two different growth approaches: i.e., thermal decomposition and chemical vapor deposition. In all instances, growth was performed on semiconducting SiC(000-1) samples in a resistively heated cold-wall reactor (HT-BM, Aixtron). For CVD growth, methane was the carbon precursor as described in [4]. Thermal decomposition was performed with the parameter set reported in [5]. Investigation of the structural, chemical and electronic properties was performed by using atomic force microscopy (AFM), Raman spectroscopy, low energy electron diffraction (LEED), X-ray photoelectron spectroscopy (XPS) and angle-resolved photoemission spectroscopy (ARPES). The number of graphene layers obtained was determined from time to time via attenuation of the SiC signal in the Raman spectra [6].
The possibility to grow with a rapid and tailored CVD process a high number of graphene layers (up to 90) with good crystallinity is extremely interesting for a number of electronic and optoelectronic applications. In particular, such turbostratic graphene has been shown to represent a favorable platform for obtaining high performance THz saturable absorbers, which would pave the way to novel graphene-based mode-locked THz lasers [4].

References

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