Nanostructuring epitaxial Graphene by Focused Ion Beam patterning

B. Prével, J-M. Benoit, L. Bardotti, P. Mélinon,

Laboratoire de Physique de la Matière Condensée et Nanostructures, Université Lyon 1, CNRS, UMR 5586, Domaine Scientifique de la Doua, F-69622 Villeurbanne, France

A. Ouerghi, D. Lucot, E. Bourhis, J. Gierak
Laboratoire de Photonique et Nanostructure – CNRS, Route de Nozay, 91460 Marcoussis, France

Contact : brigitte.prevel@univ-lyon1.fr

Since its discovery, graphene has attracted tremendous interest and their unusual properties make it a promising candidate for future electronic and optic applications [1. 2]. Along the view of designing graphene-based devices many efforts are devoted to the achievement of large scale graphene patterning in a reproducible way with controlled structural quality [3]. It is also of prior fundamental significance to further control the band gap. Recent theoretical studies demonstrated that antidot lattice can turn semimetalic graphene into a gapped semiconductor, where the size of the gap can be tuned via the geometry of the lattice [4]. The possibility to open band gaps by inducing artificial defects and the ability to control the conductivity by physical means is hence a crucial step in order to establish graphene as a competitive material for future nanoelectronics [5]. Further studies would be important to find a way to produce graphene with desired defects to modify electronic properties [6]. The functionalization is suitable way to detect imperfections in a graphene crystal lattice and to separate natural and arficial defects [7, 8].
We show in this presentation that ultra high resolution Focused ion beam (FIB) is a powerful technique for tailoring tunable defects by irradiation of a graphene sheet. FIB has the unique capability for rapid prototyping since it requires neither mask nor resist while processing [9]. Such direct writing does not require subsequent pattern transformation either. The sub-10 nm spot size achievable by the FIB method enables the patterning of diverse nanostructures at a very high resolution and offers the opportunity to functionalize surfaces with a periodic array of controlled identical extended nanodefects. nanometer scale arrays were fabricated via FIB technology in the low-current processing condition, which is promisingly useful in the construction of various templates using “Few Layer” graphene on 6H-SiC(0001). The topography of the graphene surface before and after fabrication of the patterned areas is characterized by atomic force microscopy in tapping mode. Raman spectroscopy is used to study graphene nanostructured with different ion doses. Several examples of patterned graphene will be presented.

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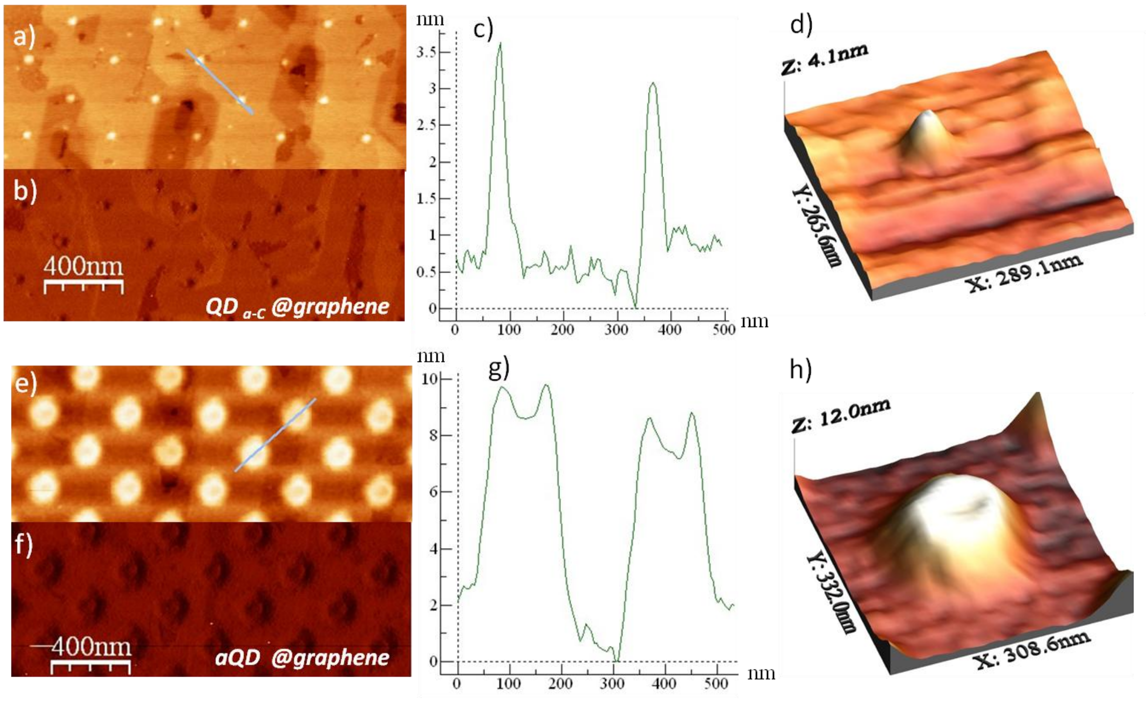
Figure



TMAFM topography image(a), (e); phase image (b), (f) and profiles (c), (g) of the morphologies of defects created by FIB on graphene for a 300 nm defect periodicity. (d), (h) represent 3D magnification of one randomly chosen defect. Top (a), (b), (c), (d) : moderate fluence 10^4 ions/dot (2×10^{16} ions cm^{-2}). Defect characteristics: bump shape, FWHM: 30 nm. Bottom (e), (f), (g), (h) : large fluence 10^6 ions/dot (2×10^{18} ions cm^{-2}). Defect characteristics: hollow pit shape, FWHM: 140 nm. The blue lines in figure 3a) and 3e) correspond to profiles given in figures 3c) and 3g)