SPM investigations of electrical properties of graphene nanostructures on 6H–SiC substrate

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Among techniques used for graphene investigation, those based on scanning probe microscopy (SPM) play an important role as they give the opportunity to perform localized experiments in nanometre scale [1]. This may be especially interesting if the electrical properties are considered, as a wide variety of electrical SPM-based techniques have already been developed [2].

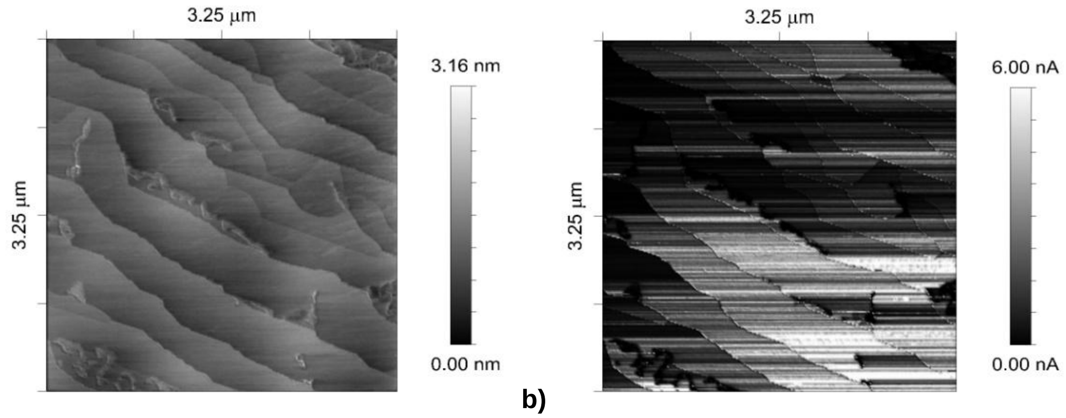
Many methods of graphene production have been considered to date, including mechanical exfoliation and chemical or thermal decomposition of silicon carbide (SiC). However, CVD techniques are most promising in terms of suitability for commercial production, although the electrical properties of CVD graphene are not as good as those of graphene fabricated using mechanical exfoliation. With use of CVD techniques, graphene may be produced on many types of substrates, including platinum, nickel, ruthenium, iridium and cobalt [3]. Epitaxy on SiC substrates may be one of the most interesting methods due to better quality of graphene grown on this material in comparison with the others [4].

In this paper we present our investigations of the CVD-grown graphene on the 6H-SiC substrate. Graphene monolayer was present in the entire investigated surface. Electrical properties of the graphene were characterized with use of the following SPM techniques: conductive atomic force microscopy (C-AFM), Kelvin probe force microscopy (KPFM) and scanning tunnelling microscopy (STM). In these techniques conductive probe approach the investigated surface and interact with it. Those interaction in result give us possibility to record data about current (C-AFM) or surface potential (KPFM). C-AFM and STM images were obtained using home-made microscopes. Current-voltage spectroscopy curves and current-load force spectroscopy curves were also recorded. We observe that electrical properties of the graphene strongly depend on substrate surface, especially at the edges of SiC terraces. Spectroscopy data show us, that electrical conductivity increases with higher values of the load force. Moreover, the contact between metallic tip and graphene on SiC exhibits tunnelling properties. KPFM measurements confirm the observations – on the edges, where strong distortion of the graphene material occurs, we observed the potential increase.

References

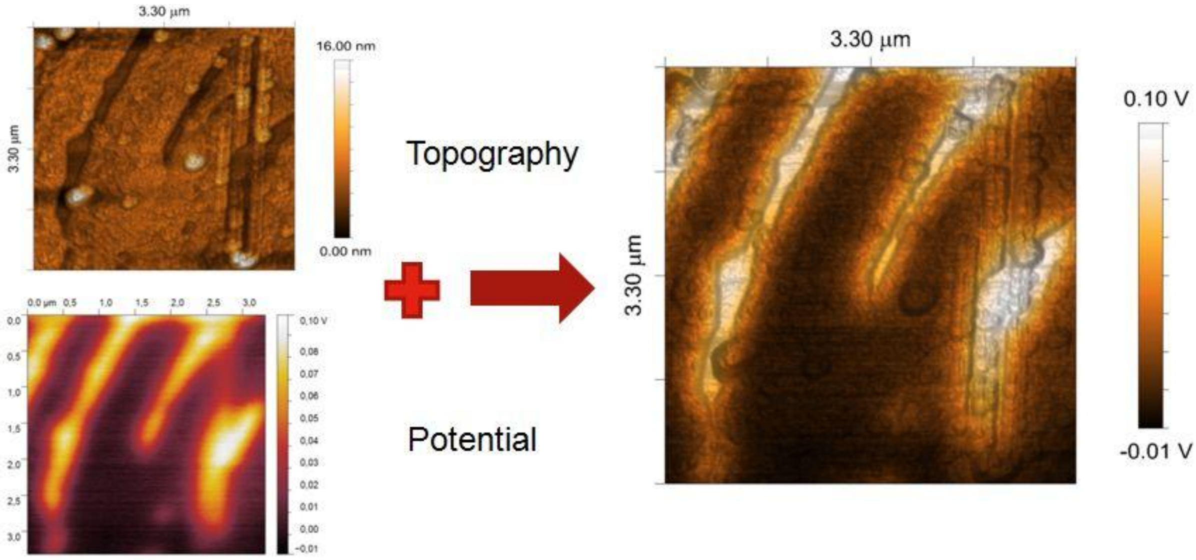
[1] U. Starke, C. Riedl, J. Phys.: Condens. Matter, **21** (2009) 134016
[2] A. Avila, B. Bhushan, Crit. Rev. Solid State Mater. Sci., **1** (2010) 38
[3] C. Soldano, A. Mahmood, E. Dujardin, Carbon, **8** (2010) 2127
[4] W. Strupinski, K. Grodecki, A. Wysmolek, R. Stepniewski, T. Szkopek, P. E. Gaskell, A. Grüneis, D. Haberer, R. Bozek, J. Krupka, J. M. Baranowski, Nano Lett., **11** (2011) 1786

Figures

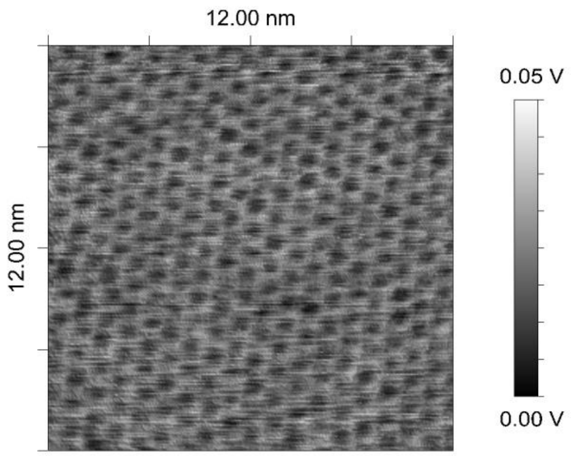


a) **b)**

Topography (a) and current (b) images of the CVD graphene grown on 6H-SiC. C-AFM image, scan area of 3.25 µm × 3.25 µm, sample bias: 0.5 V, load force: 30 nN



Potential image overlaying topography image of the CVD graphene on 6H-SiC.



STM image of moiré patterns of the CVD graphene grown on 6H-SiC