CVD Grown Monolayer Graphene Doping By Adsorbtion of V-VII Group Elements

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Abstract Graphene is very highly promising candidate for future electronics due to its two-dimensionality and an extremely high charge carrier mobility [1]. The application of graphene in future electronic devices requires control of the character and density of its charge carriers. Control of the type and density of charge carriers can be realized both by the electrostatic gate and the chemical doping methods.
While electrostatic gating has been successfully demonstrated [2], it does require a DC bias source, while the development of useful chemical doping methods, working 'off-line' is a real challenge. Different molecules such as NO_2, H_2O, NH_3 has been used for p-type doping of graphene [3]. However, NO_2, H_2O, and NH_3 are very reactive chemicals and cannot be used in an electronic material. An alternative is presented by the heavier elements, which are less reactive, and can induce the spin-orbit interaction in graphene. It is expected that bismuth as well as antimony could be able to extract electrons out of the graphene sheet. Recently, the Dirac point shift towards the Fermi level and increase of the line width of the bands for bismuth doped epitaxial graphene were predicted theoretically and shown experimentally [4]. Antimony, which is located in group V of the periodic table just above bismuth, is expected to give similar results.

Here we present the CVD grown monolayer graphene doping by adsorption methods. V-VII group elements as antimony, sulfur, iodine were used as dopants. Doping methods include both full-surface modification and local surface modification. For the local graphene surface doping antimony sulfide nanowires and nanowire clusters are used. Graphene samples are prepared for doping and further research using electronic lithography and in-situ nanomanipulation techniques. Experiments are carried out both under high vacuum and ambient conditions.

References

[1] Novoselov, K. S.; Geim, A. K.; Morozov, S. V.; Jiang, D.; Zhang, Y.; Dubonos, S. V.; Grigorieva,I.V.; Firsov, A. A., Science, **306** *(*2004), 666.
[2] Oostinga, J. B.; Heersche, H. B.; Liu, X.; Morpurgo, A. F.; Vandersypen, L. M. K. Nature Mater., **7** (2008) 151.
[3] Wehling, T. O.; Novoselov, K. S.; Morozov, S. V.; Vdovin, E. E.; Katsnelson, M. I.; Geim, A. K.; Lichtenstein, A. I. Nano Lett., **8** *(*2008) 173.
[4] Gierz, I; Riedl, C; Starke, U; Ast, C. R.; Kern, K. Nano Lett., **8** (2008) 4603.