The investigation of two-dimensional semiconducting nanostructures based on single graphene sheets with "lines" of adsorbed hydrogen

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The emergence of graphene as a stable pure two-dimensional system has been one of the most important events in electronic condensed matter physics over the last three years [1]

We systematically studied graphene based superlattices with periodically adsorbed hydrogen pairs [2].

It is shown that lines of adsorbed hydrogen pair atoms divide a graphene into electronically independent strips and form an electron waveguide or 2H-line graphene-based superlattice (2HG-SL). The electronic spectra of a “zigzag” (n,0) 2HG-SL are similar to those of armchair graphene ribbons and have similar oscillation of the band gap with the width between adjacent 2H-lines (number n). The composite dual-periodic (n,0)+(m,0) 2HG-SLs of “zigzag” strips are analyzed, with the conclusion that they may be treated as quasi-two-dimensional heterostructures (Fig. 1).The induced strain with the direction perpendicular to the hydrogen pair “lines” significantly changes the electronic structure of 2HG-SL. For example, in the case of the 2HG-SL (3n,0) (n > 2) we observed the semiconductor-metal transition. Superlattices of the (n,n) type with a “staircase” of adsorbed pairs of H atoms are semiconductors with nearly linear decreasing of the band gap with increasing n. We found that the configuration with the opposite spin (antiferromagnetic) orientation between ferromagnetically ordered edge states of the (n,n) 2HG-SL is energy favorable. We studied possible existence of the hydrogen lined waveguide junction. Finally, we suggested an experimental way of fabricating of 2HG-SL.

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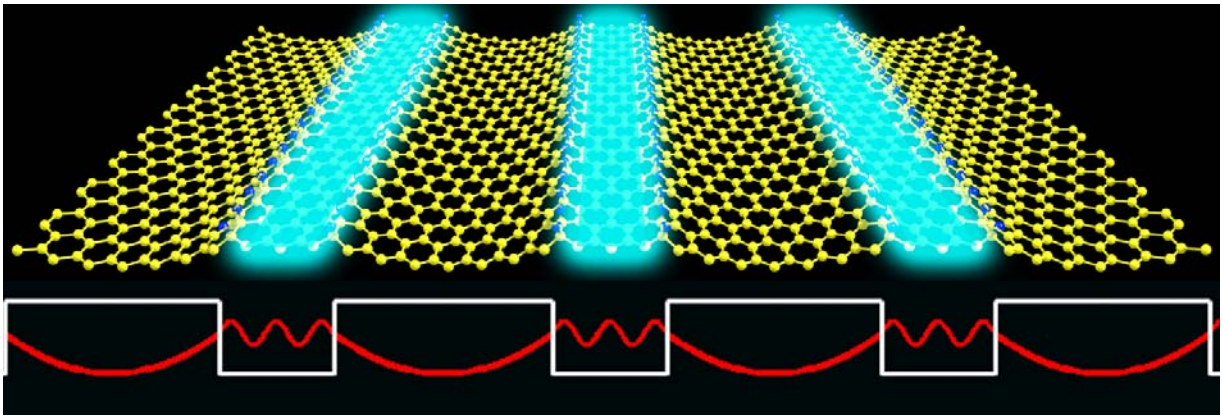

Fig. 1. (3,0)+(7,0) 2HG-SL scheme, where (3,0) strips (highlighted) are electronic waveguides.

References:

[1] K. S. Novoselov, A. K. Geim, S. V. Morozov, D. Jiang, Y. Zhang, S. V. Dubonos, I. V. Grigorieva, and A. A. Firsov, Science **306** (2004) 666.

[2] L. A. Chernozatonskii, P.B. Sorokin and J. Brüning, Appl. Phys. Lett. **91**, (2007) 183103