Interesting physics in graphene superstructures

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In this talk, I will review my recent works on physical properties of graphene superstructures with particular emphasis on their possible applications to novel electronic devices. For specific examples, three novel graphene superstructures are considered: graphene nanoribbons [1-4], graphene superlattices [5] and epitaxial graphene [6]. The unique characteristics of the massless chiral Dirac fermions are of central importance to all new physical properties presented here. For graphene nanoribbons, I have established the scaling rules for electronic energy gaps as a function of ribbon width [1-4]. Furthermore, graphene nanoribbons with a specific edge geometry are shown to have a peculiar magnetism which can be controlled by electric fields [1-4]. In particular, half-metallicity is predicted in the nanoribbons when in-plane homogeneous electric fields are applied across the edges [4]. For graphene superlattices, periodic potentials with nanoscale period are applied to two dimensional graphene and the characteristics of its charge carriers are shown to be drastically changed due to their unique chiral nature [5]. Lastly, I will report a recent discovery that a novel interfacial atomic structure occurs in graphene grown on the surface of silicon carbide (called epitaxial graphene), destroying the Dirac point of graphene and opening a substantial energy gap there [6], which are in excellent agreement with recent experiments.

References

[1] Y.-W. Son, M. L. Cohen, S. G. Louie, Nature 444, 347 (2006).
[2] Y.-W. Son, M. L. Cohen, S. G. Louie, Phys. Rev. Lett. 97, 216803 (2006).
[3] L. Yang, C.-H. Park, Y.-W. Son, M. L. Cohen, S. G. Louie, Phys. Rev. Lett. 99, 186801 (2007).
[4] Y.-W. Son, M. L. Cohen, S. G. Louie, Nano Lett. 7, 3518 (2007).
[5] C.-H. Park, L. Yang, Y.-W. Son, M. L. Cohen, S. G. Louie, Nature Physics 4, 213 (2008).
[6] S. Kim, J. Ihm, H. J. Choi, Y.-W. Son, Phys. Rev. Lett. 100, 176802 (2008).