Electronic structure of graphene hybrid systems: Screening and interactions

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Abstract

We consider the effect of adsorbates and substrates on the electronic screening and electron-electron interactions in graphene. First, resonant scatterers such as hydrogen adatoms can strongly enhance the low-energy density of states in graphene. We study the impact of these impurities on electronic screenin and find a two-faced behavior: Kubo formula calculations reveal an increased dielectric function ε upon creation of midgap states but no metallic divergence of the static ε at small momentum transfer $q \rightarrow 0$. This bad metal behavior manifests also in the dynamic polarization function and can be directly measured by means of electron energy loss spectroscopy. A new length scale l_c beyond which screening is suppressed emerges, which we identify with the Anderson localization length [1].
We then address the question of how strong Coulomb interactions in graphene derived materials are: Free standing graphene is shown to feature simultaneously strong local (U/t~3.3) and non-local Coulomb interaction terms [2]. Based on the Peierls-Feynman-Bogoliubov variational principle we show that the non-local Coulomb interactions can effectively screen the local interactions and stabilize the Dirac electron sea in graphene [3]. Interestingly, the ratio of the local to the non-local Coulomb interaction can be controlled by a metallic substrate, which efficiently screens non-local Coulomb terms.

References

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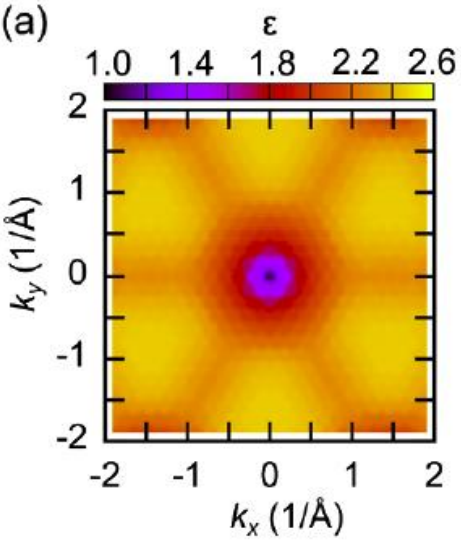
[2] T. Wehling, E. Şaşıoğlu, C. Friedrich, A. Lichtenstein, M. Katsnelson, and S. Blügel, Phys. Rev. Lett. **106**, 236805 (2011).
[3] M. Schüler, M. Rösner, T. Wehling, A. Lichtenstein, M. Katsnelson, arXiv:1302.1437 (2013).

Figures



Effective Coulomb interactions in graphene: Contribution to the static dielectric function in graphene due to the σ-bands, which controls the effective interactions strength of the π-electrons. From [2]