

Quantum Hall Effect in Chemically Functionalized Graphene: Oxygen Adsorption Fingerprints

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Abstract

In this work [1], we predict a strong electron-hole asymmetry in the Quantum Hall regime in graphene, due to its functionalization by low concentration of oxygen impurities in epoxy position. The scattering potential induced by these impurities is modeled by tight-binding parameters extracted from *ab initio* calculations [2], which, in turn, are used inside an efficient real space order N method [3] to calculate the dissipative conductivity [4] under high field. Various transport regimes are observed by varying the impurity concentrations from 0.5 to 4.4% and magnetic fields ranging from 1 to 80 Tesla, thus evidencing the complexity of the metal-insulator transition in disordered graphene under high magnetic fields. For lowest concentration of defects (0.5 to 1%), the electronic charge carriers feel substantial localization effects without any Landau levels developing in the spectrum. In contrast, the hole spectrum maintains the anomalous Quantum Hall state with associated Landau levels. Moreover, the conductivity exhibits a double-peak structure, which is associated to magnetic field-induced impurity bound states. The length-dependent conductivity proves the formation of mobility edges separating extended states from localized ones. Increasing even further the impurity concentration (up to 4.4%), we observe a complete disappearance of the quantum Hall effect in oxidized graphene, even for highest magnetic fields.

References

- [1] N. Leconte, F. Ortmann, A. Cresti, J.-C. Charlier, and S. Roche, submitted (2013)
- [2] N. Leconte; A. Lherbier, F. Varchon, P. Ordejon, S. Roche, and J.-C. Charlier, Phys. Rev. B **84** (2011) 235420; N. Leconte, J. Moser, P. Ordejon, H.H. Tao, A. Lherbier, A. Bachtold, F. Alsina, C.M.S. Torres, J.-C. Charlier, and S. Roche, ACS Nano **4** (2010) 4033
- [3] H. Ishii, F. Triozon, N. Koboyashi, K. Hirose, and S. Roche, C.-R. Physique **10** (2009) 283
- [4] D. Soriano, N. Leconte, P. Ordejon, J.-C. Charlier, J.J. Palacios, and S. Roche Phys. Rev. Lett. **107** (2011) 016602; N. Leconte, D. Soriano, S. Roche, P. Ordejon, J.-C. Charlier, and J.J. Palacios, ACS Nano **5** (2011) 3987

Figures

