

Electronic transport and flicker noise in graphene structures

Submitted by Alexey A. Kaverzin to the University of Exeter as a
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Alexey A. Kaverzin
November, 2011

Abstract

In this thesis the properties of graphene are studied via the various aspects of the quantum transport: doping of the graphene surface with organic molecules, flicker noise and transport in the quantum Hall regime.

First, it was shown that certain molecules (toluene, aniline and water), which possess such common properties as non zero dipole moment and ability to undergo the electrochemical reaction, have a peculiar doping effect on graphene. The effect of toluene doping was studied in detail and is explained by the electrochemical reaction, which takes place in the vicinity of the graphene and results in a gate voltage dependent doping.

Second, the flicker noise in graphene and its relation to the scattering mechanisms were studied. The flicker noise as a function of the carrier concentration was demonstrated to be sensitive to the scattering potential determining the resistance of the graphene. Therefore, as it was suggested, the flicker noise can be used as a tool for determining the dominant scattering mechanism in graphene, although it was found that the resistance and noise can originate from different scattering potentials.

Also, the flicker noise spectrum was shown to decompose into individual lorentzians at low temperatures (below ~ 25 K), where the fluctuations of the resistance is supposedly coming from the random jumps of electrons between the conductive channel in the graphene flake and the nearby impurity states.

Third, the transport properties of the bilayer/trilayer graphene structure were studied at different temperatures and different magnetic fields including the quantum Hall regime. Bilayer and trilayer parts of the sample revealed the signatures of the quantum Hall effect predicted theoretically. The transport through the interface between bilayer and trilayer parts was also investigated. Signatures of the interface resistance were seen, although the observed behaviour is not explained. Under high magnetic fields the properties of the interface longitudinal resistance were described qualitatively by the classic transport equations.

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