Electronic transport and flicker noise in graphene structures

Submitted by Alexey A. Kaverzin to the University of Exeter as a thesis for the degree of Doctor of Philosophy in Physics
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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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# Contents

Abstract 2

Acknowledgements 3

Contents 4

List of Figures 7

List of Tables 15

Introduction 16

1 Theoretical background, sample fabrication and measurement techniques 18
   1.1 Dispersion relation 18
      1.1.1 Monolayer of carbon atoms 18
      1.1.2 Tight-binding approximation 19
      1.1.3 Linear dispersion relation 22
   1.2 Sample fabrication and measurement techniques 25
      1.2.1 Graphene fabrication 25
      1.2.2 Typical $R(V_G)$ dependence 27
      1.2.3 PMMA-free samples 28
   1.3 Scattering 31
      1.3.1 Introduction 31
      1.3.2 Scattering mechanisms 31
   1.4 Noise 35
      1.4.1 Thermal noise 36
      1.4.2 Random telegraph noise 36
CONTENTS

1.4.3 $1/f$ noise ............................................. 37

2 Electrochemical doping of graphene ............................................. 39
  2.1 Introduction ........................................................................... 39
  2.2 Experimental setup ................................................................. 40
  2.3 The role of $\pi-\pi$ interaction in the doping by organic molecules ...... 41
  2.4 The role of the dipole moment .................................................. 45
  2.5 Electrochemical doping ............................................................... 47
    2.5.1 Timescale of the effect and hysteretic behavior ....................... 47
    2.5.2 Molecular doping mechanism ................................................ 49
    2.5.3 Characteristic times ............................................................. 51
    2.5.4 Enhancement of the doping by electric field ............................... 55
    2.5.5 Doping dependence on the gate voltage ................................... 56
    2.5.6 Effect of pumping and annealing ............................................ 58
    2.5.7 The third reactant .............................................................. 62
    2.5.8 Electrochemical reaction ...................................................... 63
  2.6 Conclusions ............................................................................ 70

3 Random telegraph signals and flicker noise in graphene .................. 71
  3.1 Introduction ............................................................................ 71
  3.2 Experimental techniques ............................................................ 72
  3.3 Scaling of the noise with frequency .......................................... 75
  3.4 Room-temperature effects .......................................................... 76
    3.4.1 Lock-in amplifier and spectrum analyser comparison ................. 76
    3.4.2 Flicker noise as a function of gate voltage ................................. 77
    3.4.3 A simple theoretical model .................................................... 80
  3.5 Temperature dependence of the flicker noise ............................... 85
    3.5.1 Experimental results ............................................................ 85
    3.5.2 Theoretical description of the temperature dependence of flicker
          noise ................................................................................. 86
    3.5.3 An example of fitting M-type dependence of the noise ............... 89
  3.6 Random telegraph signals (RTS) in graphene nanoribbon ............... 91
    3.6.1 $1/f$ spectra as a sum of lorentzians ...................................... 91
    3.6.2 RTS time dependence ......................................................... 92
3.7 Flicker noise in samples on $\text{Si}_3\text{N}_4$ ................................. 97
3.8 Conclusion ................................................. 99

4 Quantum transport in graphene structures at high magnetic fields 102
  4.1 Introduction and sample description ................................. 102
  4.2 Temperature dependence ........................................... 104
    4.2.1 $R(V_G)$ dependence ...................................... 104
    4.2.2 Theoretical expectations .................................... 105
    4.2.3 Temperature dependences .................................... 107
  4.3 Quantum Hall regime .............................................. 111
    4.3.1 Change of the measurement scheme ............................ 111
    4.3.2 Trilayer graphene in the Quantum Hall regime ................ 111
    4.3.3 Bilayer graphene in the quantum Hall regime ................ 118
    4.3.4 Interface resistance in strong magnetic field ................ 120
  4.4 Conclusion .................................................. 125

5 Suggestions for further work ......................................... 126

Bibliography .................................................................. 128

A Statistics of the samples ............................................ 134