Observation of low-field magnetoresistance in graphene at room temperature

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Abstract

Graphene is a highly attractive material because it exhibits quantum properties of two-dimensional electron gas (2DEG) [1-9]. In particular, graphene has high carrier mobility, weak spin-orbit coupling and long spin lifetime [6-9]. The magnetic dependence of electronic transport in graphene is important to the fundamental physics and potential application. The magnetoresistance (MR) and quantum Hall effect (QHE) of graphene has been studied in large magnetic field and low temperature [3-5].

We have studied low-field magnetoresistance in single-layer graphene (SLG) at room temperature (RT). The SLG was synthesized by chemical vapor deposition (CVD) on copper foil and transferred to Si wafer. The size of the graphene is about 1 cm. The gold wires were patterned as the electrodes on the graphene, and electronic properties were studied using four-point measurements with the constant current mode. The magnetic field was applied perpendicular to the film. Figure 1 shows the MR curve in the SLG at low field range of 25 mT. The resistance R of SLG shows hysteresis behavior with the applied field. The R difference at zero magnetic field between the ascending and descending branches $\Delta R_{H=0}$ depends on the injected current (gate voltage), as shown in Fig. 2, and has a maximum about 100 Ω (0.5% of R) at the injected current of 0.05 mA which is close to the Dirac point of the SLG (about 1 V gate voltage).

The Dirac point in graphene depends on the defect or impurity [7,8]. The edge states with defect or impurity can result in weak ferromagnetic behavior [7]. We suggest that the observed low-field magnetoresistance behavior is related to the defect or impurity in the SLG. Our results can extend better understanding of the magnetic and electronic properties of graphene.

References

[1] K. S. Novoselov *et al*., Science, **306** (2004) 666-669.
[2] C. Berger *et al*., J. Phys. Chem. B, **108** (2004) 19912-19916.
[3] K. S. Novoselov *et al*., Nature **438** (2005) 197-200.
[4] Y. Zhang *et al*., Nature **438** (2005) 201-204.
[5] C. Berger *et al*., Science, **312** (2006) 1191-1196.
[6] N. Tombros *et al*., Nature **448** (2007) 571-574.
[7] A. H. Castro Neto *et al*., Rev. Mod. Phys. **81** (2009) 109-162.
[8] S. Das Sarma *et al*., Rev. Mod. Phys. **83** (2011) 407-470.
[9] B. Dlubak *et al*., Nature Phys. (2012) DOI: 10.1038/NPHYS2331.

Figures

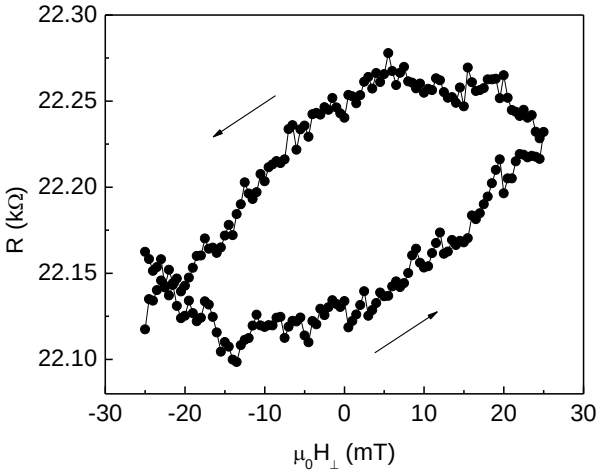

Figure 1. Low magnetic field dependence of resistance in the graphene with the injected current of 0.05 mA.

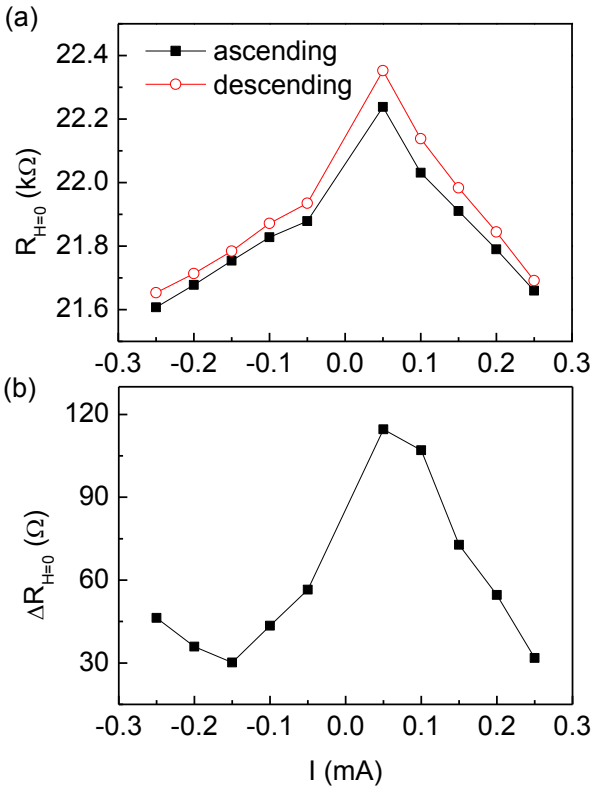

Figure 2. (a) Resistance of SLG as a function of the injected current at zero magnetic field for the ascending and descending branches, respectively. (b) The resistance difference at zero magnetic field between the ascending and descending branches $\Delta R_{H=0}$ dependence on the injected current.