Electron Transport in Ultrahigh Mobility Graphene

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Introduction

Graphene, a single layer of carbon atoms arranged in a hexagonal lattice, is the most recent addition to the family of two-dimensional materials. Its remarkable energy dispersion relation, akin to that of relativistic Dirac fermions, opens the possibility both of observing new many-body physics and exploring quantum electrodynamics in bench-top experiments. Beside fundamental research, graphene also has promise as a new technological material, owing to its high room-temperature mobility, its ability to sustain large (>10^8 A/cm^2) current densities, and its exceptional mechanical strength.

Experiment Results

Due to interactions with the underlying substrate on which graphene is typically fabricated, the low-temperature carrier mobility in prior transport experiments has been limited to ~ 20,000 cm^2/Vs. By etching away the substrate underneath the graphene (as shown in the four-terminal device of Fig. 1) we have isolated suspended graphene with low-temperature mobilities ten times as large.[1] The room temperature mobilities of these devices, reaching upwards of 100,000 cm^2/Vs, can exceed that of conventional semiconductors. This ultrahigh mobility for the device shown in Fig. 1 can be seen qualitatively in the Shubnikov-de Haas oscillations present in its magnetoresistance (Fig. 2).

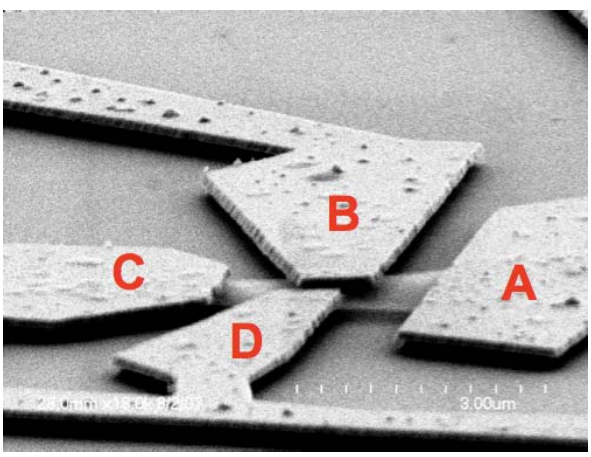

Fig. 1

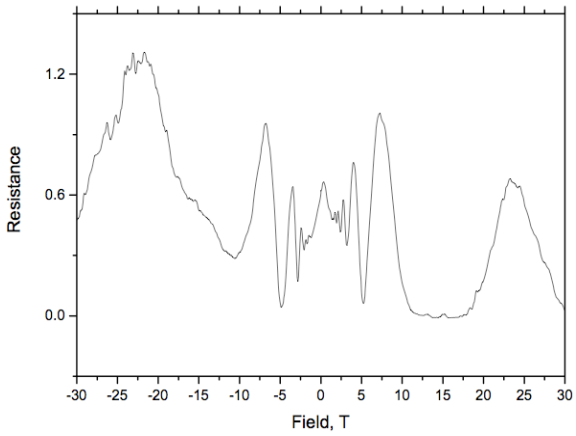

Fig. 2

The onset of these oscillations in suspended devices at fields several times lower than observed in conventionally fabricated graphene with the same carrier density is consistent with longer scattering times.[2] By increasing these times through the elimination of extrinsic scattering elements, the possibility is increased of observing intrinsic 2D many-body behavior in graphene, such as the fractional quantum hall effect.

Acknowledgements

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References

[1] Bolotin, K. I., *et al*., Solid State Commun., **146**, 351-355 (2008).
[2] Bolotin, K. I., *et al*., Phys. Rev. Lett., **101**, 096802 (2008).