Experimental observation of quantized edge conduction in graphene point contacts

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Abstract

The zigzag edges of graphene, whether single or few layers, host zero energy gapless states which are protected against back-scattering and are perfect one dimensional conductors. Despite extensive studies of their local thermodynamic and magnetic properties, a direct evidence of edge state electrical conduction has remained elusive. In this talk we report the observation of edge bound transport in atomic-scale constrictions of single and multilayer suspended graphene created by nanomechanical exfoliation of graphite. We observe that the conductance is quantized in close multiples of e2/h, the universal quantum of conductance. A split zero bias anomaly in non-equilibrium transport and hysteretic magneto-conductance strongly indicate conduction via spin polarized edge states in the presence of electron-electron interaction. We demonstrate that the quantization of conductance is a result of transport along a nearly perfect zigzag edge of the nanoexfoliate. This was confirmed with extensive atomic force microscopy of the edge geometry formed during mechanical exfoliation, which suggests tearing along crystallographic angles with a high fidelity of the edge morphology. Transport through edge states will be an invaluable resource for room temperature ballistic circuits, spintronics and quantum information technology.

References

[1] Amogh Kinikar, T. Phanindra Sai, Semonti Bhattacharyya, Adhip Agarwala, Tathagata Biswas, Sanjoy K. Sarker, H. R. Krishnamurthy, Manish Jain, Vijay B. Shenoy and Arindam Ghosh, Nature Nanotechnology (2017) (Accepted for publication)

Figures

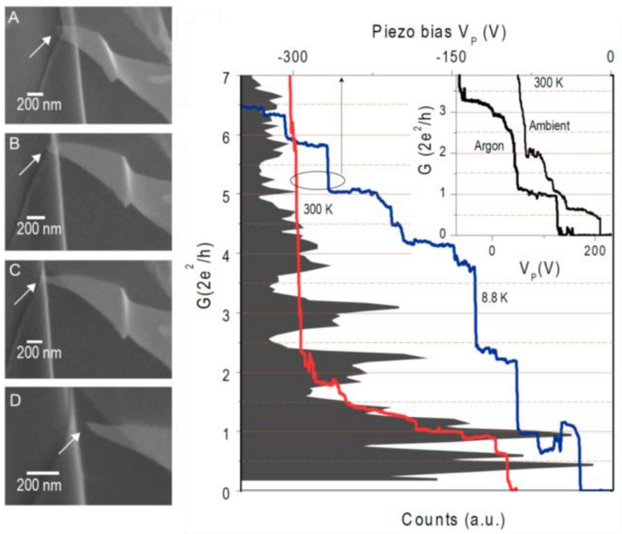

Figure 1: electrical and structural evolution during nanoscale exfoliation of graphene point contacts. Left: (A-D) Progressive exfoliation of graphite forming a graphene nanoconstriction. Right: Electrical conductance of the nanoconstriction during the exfoliation process.