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 $e^2/h$, 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


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.