Exploring quantization in graphene nanoribbons

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Conductance quantization is a defining feature of electronic transport in quasi-one dimensional conductors. In the absence of a magnetic field, confinement results in a sequence of transverse sub-bands with an increasing number of nodes across the device width. In a magnetic field within the quantum Hall regime, transmission is through chiral edge states surrounding a gapped bulk. Here I examine two recent experiments [1,2] displaying unexpected quantization features.

Firstly, I show that a non-uniform gate-induced charge density introduces new transmission channels within the quantum Hall regime for exfoliated graphene nanoribbons on SiO_2 [1] (Fig 1). Unlike the standard quantum Hall edge states, these channels are highly susceptible to disorder and break the expected quantization sequence in two-terminal measurements. Counterintuitively, the suppression of quantization is most evident for weak edge disorder, and a strong edge disorder reintroduces the expected quantization sequence.

Secondly, graphene nanoribbons grown on the sidewalls of SiC mesa structures have previously[3] been shown to present a 1D ballistic channel at the micron scale. New 2-point measurements reveal additional quantised channels at shorter probe separations [2] (Fig 2). Furthermore, these channels are localised in different regions across the ribbon width. These findings are consistent with a model accounting for asymmetric interfaces between the SiC and nanoribbon at each edge.

References

[1] J.M. Caridad, S.R. Power *et al*, **Nat. Commun.** 9 (2018) 659
[2] J. Aprojanz, S.R. Power *et al*, **in preparation** (2018)
[3] J. Baringhaus *et al*, **Nature** 506 (2014) 349

Figures

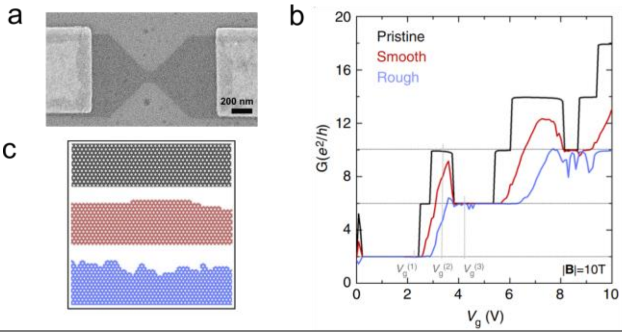

Figure 1 Experimental geometry (a) and simulated conductance (b) for different edge disorders (c) for graphene nanoribbons on SiO_2. The expected plateau sequence is restored for stronger edge disorder.

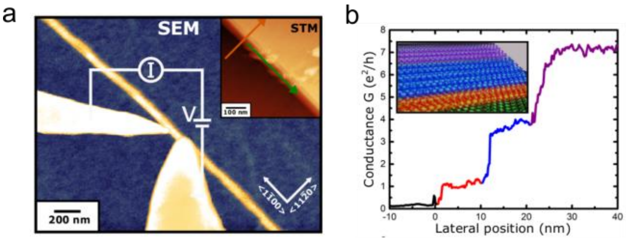

Figure 2: 2-point probe setup (a) and conductance vs. probe position across ribbon width (b) for sidewall graphene nanoribbons on SiC.