Effect of local morphology on charge scattering in the quantum Hall regime of epitaxial graphene

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Graphene monolayers on the surface of silicon carbide are often decorated with bilayer inclusions that modify the local bandstructure and density of electronic excitations (Fig.1 (a) and Ref. [1]). In high magnetic fields, they are also thought to affect electron trajectories, leading to dissipation even in the quantum Hall regime [2]. We examine the influence of layer morphology on the quantum Hall effect by perturbing the potential around bilayer inclusions using the tip of a scanning probe microscope at 5 K, in a similar manner to Ref. [3]. Even within the quantum Hall regime of the filling factor ν=2 plateau (Fig. 1(b)), the conductance of the device is strongly affected when the tip is at pinch points between bilayers (Fig.1 (c)), suggesting that counter-propagating edge channels are guided into proximity there. Using the electric field from the scanning probe tip to reduce the local layer-induced carrier density modulation, we are able to suppress backscattering at pinch points and recover the near-perfect transmission required for graphene quantum resistance metrology [4] (Fig.1 (d)). Our results both highlight the need to minimise the proximity of bilayer inclusions in samples destined for resistance metrology, and also illustrate the possibility of engineering layered structures to guide electron trajectories.

References

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Figures

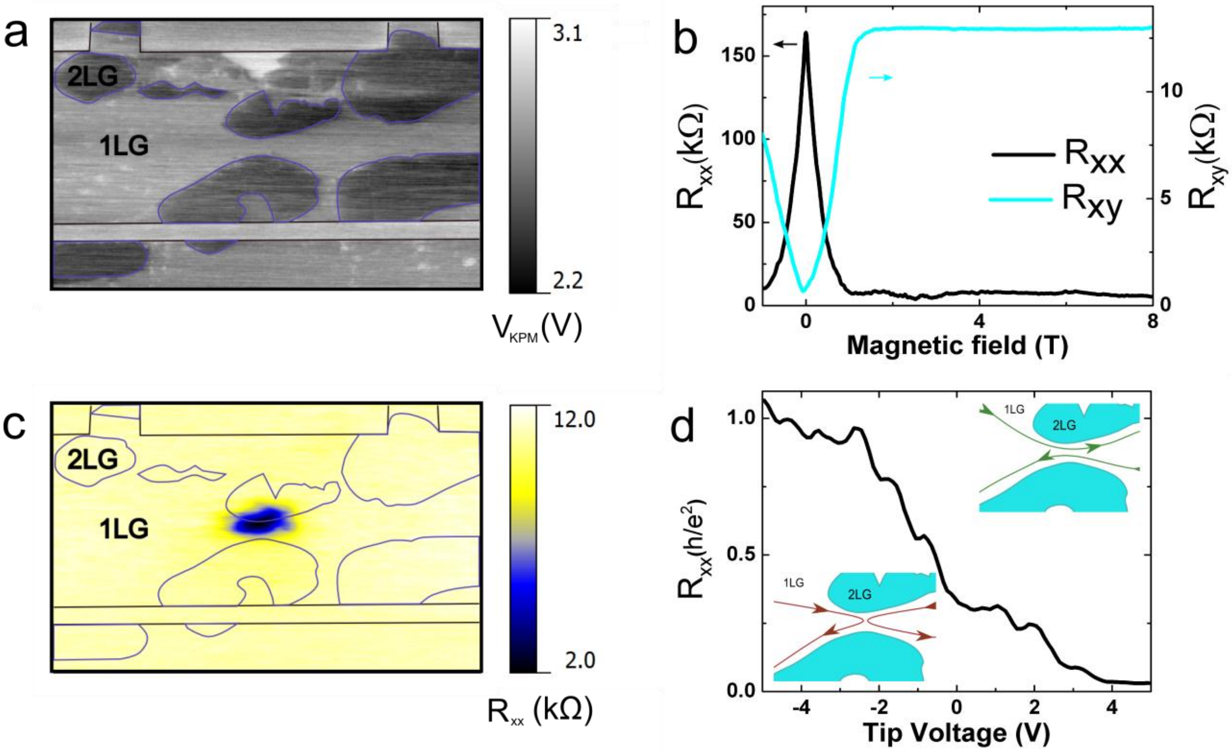

Fig.1. (a) Room temperature Kelvin probe microscopy image of a 2 μm-wide Hall bar defined in epitaxial graphene. Dark regions correspond to bilayers surrounded by monolayer graphene. (b) Magnetoresistance plot of device at T=5 K. (c) Scanning gate image showing the longitudinal resistance as a function of tip position in the quantum Hall regime (B=1.5 T, T=5 K). (d) Longitudinal resistance as a function of tip voltage at B=1.5 T with the tip parked over the pinch point between bilayers. Insets show possible edge-state trajectories at negative and positive tip voltages.