Graphene Quantum Hall for Quantum Resistance Standard

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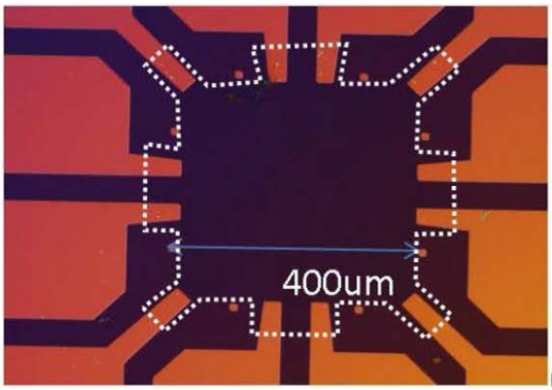
Introduction

Graphene has shown half integer quantum Hall effects (QHE) up to room temperature, opening exciting possibilities for future quantum resistance metrology using graphene. For high precision measurement, high current input (up to mA) without significant Joule heating is necessary to increase the resolution and minimize the effect of background noise, thus making QHE devices of larger size desirable.

Experimental

We have fabricated QHE devices on a few hundred microns sized CVD graphene films as shown in **Figure 1** with graphene films on top of the metal contacts. This fabrication process greatly reduced the contact resistance between the graphene and metal contacts, which results in a much better QHE, as shown in Figure 1 (b) with minimum R_{xx} less than an ohm, and contact resistance less than 10 ohms (exclude wire resistance in the probe).

(a)



(b)

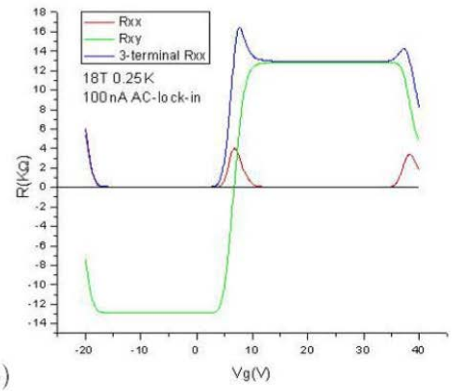


Figure 1: (a) Picture of the 380μm×380μm^2 graphene device on a SiO_2/Si substrate. (b) 4-terminal Longitudinal resistance R_{xx}, Hall resistance R_{xy} and 3-terminal R_{xx} for the CVD graphene measured at 0.25K with a magnetic field of 18T.

Results and Discussion

We have also studied the size dependent universal scaling from plateau to plateau transitions, as shown in **Figure 2**. Unlike those reported for GaAs [1] we see very weak size dependency of the saturation temperature for graphene device sizes from 2*μ*m up to 7mm. We contribute this to possibly unique delocalization mechanisms in graphene systems that may be related to the electron-hole puddles and/or grain structures in CVD graphene.

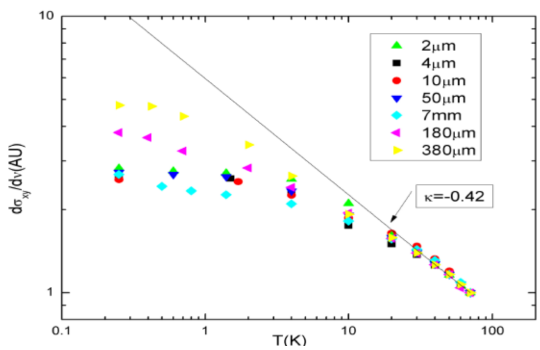


Figure 2: Size dependent universal scaling. $(d\sigma_{xy}/d\upsilon)^{max}$ for the υ=-6 to -2 transition.

Conclusions

Our studies show the large size CVD graphene is promising for quantum Hall metrology, and to study quantum Hall transitions and scaling behavior.

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References

Li *et al*., PRL **102**(21):216801 (2009).