Transition from weak localization to strong localization regime in the bilayer graphene

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Weak localization (WL) effect occurs in a broad range of disordered conductors including graphene, two-dimensional honeycomb lattice of carbons. It is suppressed by the external magnetic field B, and the longitudinal resistance R_{xx} decreases as increasing B. The WL in graphene is attributed to the chiral nature of valley degree of freedom [1]. The WL in graphene has been studied extensively [2,3], however, there still remain unknown aspects in the behavior of R_{xx} in the presence of B. Here we report on the resistance fluctuation that is observed in the bilayer graphene sample at low temperatures.

The sample is fabricated by the method of mechanical exfoliation of natural graphite. The bilayer flake is deposited on the SiO_2 surface separated by 300nm from n^+ Si substrate and cooled by the helium-free refrigerator. The mobility is approximately 2,500 cm^2/Vs at room temperature. Figure 1 (a) shows the longitudinal resistance R_{xx} as a function of V_g for 17 K and 7 K. After anneal, we find that Dirac point shifts to V_g = -36 V. R_{xx} increases as temperature decreases, and R_{xx} shows a reproducible oscillation at 7 K. Figure 1 (b) shows R_{xx} at different values of V_g marked by arrows in Fig. 1 (a) as a function of B. We see that every traces of R_{xx} decreases in the presence of B and takes a minimum value, then gradually increases as B further increases. This behavior is well explained by the competition between the suppression of the WL in the low B and the strong localization in the high B. Moreover, we find that the trace of R_{xx} at V_g = -42.7 V, which corresponds to the minimum point in the oscillated R_{xx} at B =0 T, takes the minimum at a smaller B value (~ 0.2 T) than the other two traces that takes the minimum at approximately ~0.5 T. We compare the results with the theory [1] and discuss the intervalley scattering rates in the conference.

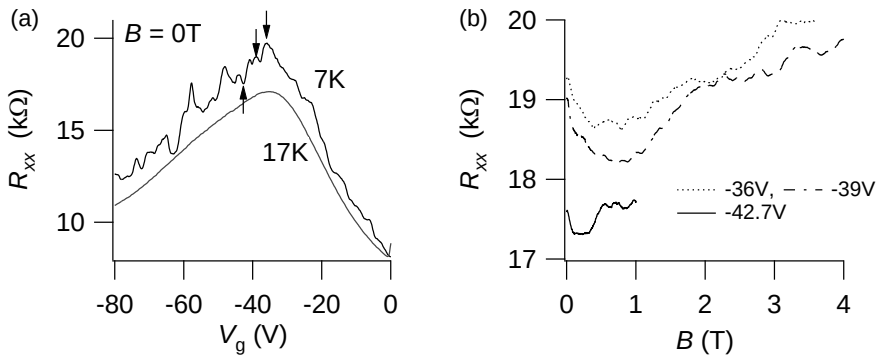

Figure 1 (a) R_{xx} as a function of V_g for different temperatures at 17 K and 7 K at B =0 T. (b) R_{xx} at different values of V_g corresponding to the position marked by arrows in (a) as a function of B.

[1] E. McCann, *et al*., Phys. Rev. Lett., **97** 146805 (2006).
[2] R. V. Gorbachev *et al.*, Phys. Rev. Lett. **98**, 176805 (2007).
[3] F. V. Tikhonenko, *et al.*, Phys. Rev. Lett. **100**, 056802 (2008).