Ballistic transport in graphene *p-n* junctions

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P-N junctions in graphene promise to be a platform for investigating peculiar transport phenomena of Dirac fermions such as Klein tunneling and negative refraction. In order to observe these phenomena, we need graphene *p-n* junctions in which the charge carrier travels ballistically. However, in the conventional graphene *p-n* junctions, the interaction between graphene and substrate material degraded the charge carrier mobility. In this work, we fabricated high-mobility graphene *p-n* junctions by sandwiching graphene between two hexagonal boron-nitride (h-BN) crystals. The resistivity peak as a function of back-gate bias voltage was narrow (δV_{BG}^{FWHM} ~ 1 V), demonstrating high quality of our device. By tuning the global back gate (V_{BG}) and local top gate (V_{TG}), we formed *p-p*' and *p-n* junctions [Fig. 1]. When *p-p* junction was formed (V_{TG} = 0 V), characteristic peak structures were emerged in bend resistance $R_{CD,AB}$ plot [Fig. 2]. The positions of the peaks were well fitted by the curves with constant cyclotron radius R_c. This result indicates that the peak structures were caused by the charge carriers focused onto the voltage probe C from A by the ballistic carrier trajectory shown in Fig. 1. When the top gate voltage V_{TG} was varied, we observed the shift of the positions of focusing signals. We will discuss this result in terms of the change of the electron wave's refractive index at the *p-n* junctions.

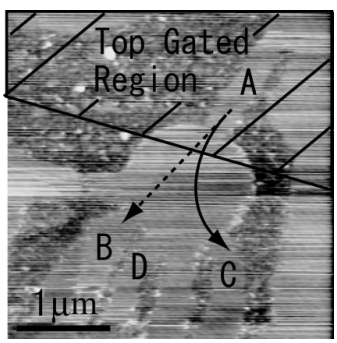

Fig. 1: AFM image of the representative device before transferring the top BN. The top gated region subsequently deposited is also depicted. The solid and dotted arrows indicate a ballistic carrier trajectory and a current direction, respectively.

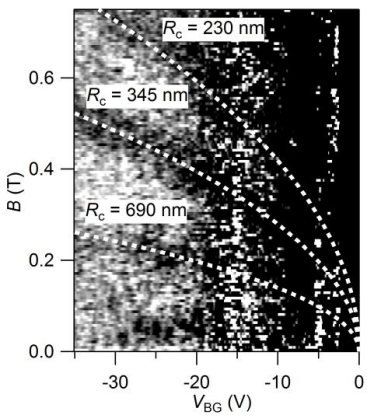

Fig. 2: Gray scale plot of bend resistance $R_{CD,AB}$ as a function of V_{BG} and B with V_{TG} = 0 V. The white dotted curves correspond to cyclotron radius R_c = 230, 345, 690 nm (top to bottom), suggesting the focusing of carriers onto the voltage probe C shown in Fig. 1.