Infrared Photoresponse of High-Mobility Graphene in the Quantum Hall Regime

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The linear electronic band structure of graphene has lead to the formation of unequally and uniquely spaced Landau levels in graphene. Here, we report on the infrared photoresponse of high-mobility graphene devices due to the cyclotron resonance. In photoresponse signals, we observed two types of signals. The photovoltaic photoresponse was dominant at high temperature (T > 20 K) and low bias currents (I < 100 nA), whereas the bolometric effect was dominant at low temperature (T < 20 K) and high bias current (I > 100 nA). The photovoltaic photoresponse was sustained even up to T = 180 K.

We fabricated graphene/boron nitride Hall-bar devices using the mechanical transfer technique of graphene on hexagonal boron nitride. The fabricated device exhibited high mobility $\mu \sim 110{,}000\ \mathrm{cm^2/Vs}$ at T = 4 K. The sample was irradiated by CO_2 laser light with the wavelength of λ = 10.6 µm. In the photoresponse signals measured at high temperature (T > 20 K) and zero bias current, positive and negative photoresponse signals (ΔV) were emerged at $\nu = \pm 2$ quantum Hall states [Fig. 1(b)]. The amplitude of ΔV was independent of I, indicating that the photoresponse signal was due to photovoltaic effect. On the other hand, when ΔV were measured at low temperature (T < 10 K) and finite bias current I = 100 nA, ΔV were emerged at quantum Hall transition regions between ν = -6 -> -2, -2 -> 2 and 2 -> 6. The amplitude of ΔV was linearly dependent on I and decayed quickly as the temperature was raised, indicating that the photoresponse signal was due to bolometric photoresponse.

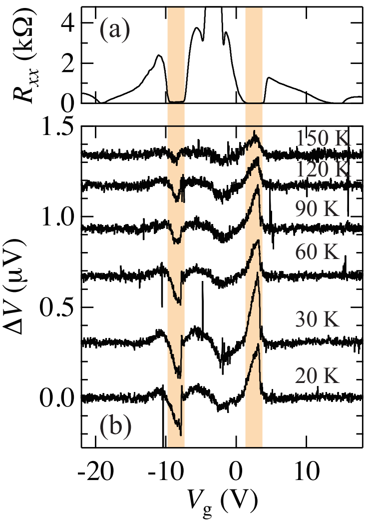

FIG. 1: (a) Longitudinal resistence R_{xx} and (b) photovoltaic response ΔV as a function of back-gate bias voltage V_g measured in magnetic fields of B = 8 T.

These results were in contrast to the case of the conventional low-mobility graphene on SiO_2, where the photoresponse signal was limited to bolometric effect. This observation suggests the emergence of intrinsic photoresponse in graphene by improving the charge carrier mobility. When the temperature was raised, the photovoltaic signal was sustained up to T = 180 K, indicating the possibility for developing high-temperature operating IR detectors using graphene.