Photocurrent Spectroscopy Study of Bilayer Graphene

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Introduction

Bilayer graphene is a fascinating system where the bandgap can be continuously tuned from zero to 250 meV simply by applying a vertical electric field. This tunable bandgap provides a fertile ground to study the many-body physics of a tunable semiconductor bandgap. At the same time, graphene is an ideal system for optical study of the quantum hall physics due to its high intrinsic quality. Previous infrared measurements of graphene was limited by the low sample quality and technical difficulty in measurement. We proposed to study the magneto-infrared properties of high quality bilayer graphene with a novel photocurrent spectroscopy method.

Experimental

We fabricated high quality bilayer graphene samples encapsulated between hexagonal boron nitride substrates. The magneto-infrared spectroscopy measurement was done at SCM3 under a magnetic field up to 17.5T.

Results and Discussion

We constructed a photocurrent setup by combining the FTIR spectrometer with the superconducting magnet at SCM3. By performing the photocurrent spectroscopy measurement, we were able to get the absorption spectrum of band-gapped bilayer graphene with unprecedented energy resolution and signal-to-noise ratio from mid infrared to far infrared range.

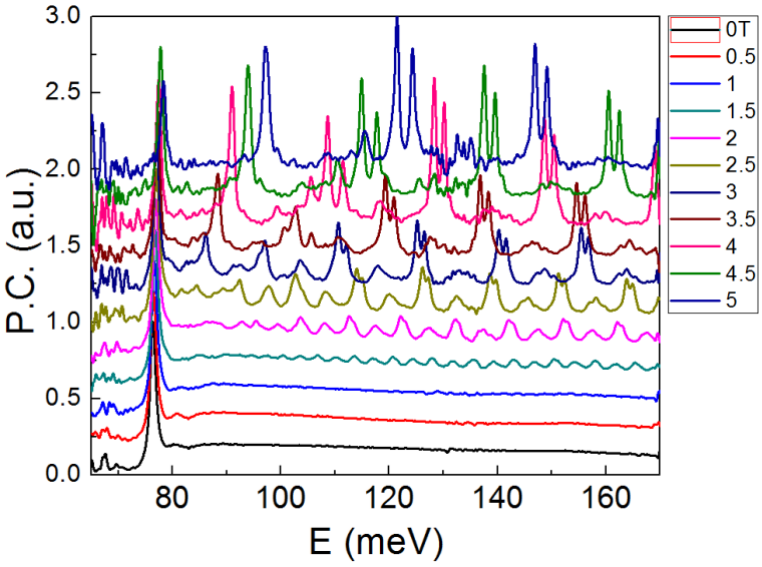

Fig. 1 shows the photocurrent spectrum of bilayer graphene at a magnetic field of 0-5 Tesla. Many sharp peaks appear in the spectrum as a result of inter Landau level transitions. Due to the high quality of our sample, the typical linewidth of these peaks is ~1 meV, more than one order of magnitude narrower than peaks that were observed in previous infrared measurement of graphene. At the same time, the observed spectrum is qualitatively different from previous infrared absorption spectrum of graphene. Many new peaks are observed and fine features such as splitting of peaks are clearly revealed.

Conclusions

The observed absorption spectrum of bilayer graphene in magnetic field shows many transitions that disobey the usual optical selection rules between Landau levels. This is a result of the unique band structure and manybody interaction in bilayer graphene. Further studies are underway.

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References

[1] Ju, L., *et al*., in preparation.