Optical Study of Magneto-plasmons and Interaction Effects in Graphene

Hugen Yan, Phaedon Avouris, and Fengnian Xia (IBM), Zhiguo Chen, Zhiqiang Li (NHMFL)

Introduction

The fundamental physics of graphene is of great interest. Recently plasmons in graphene have attracted a lot of interest due to their rich physics and great potential for applications. Since the plasmons are collective oscillations of Dirac fermions in graphene, a comprehensive investigation of plasmons using magneto-optical spectroscopy will provide new insights into many body interactions in graphene.

Experimental

In our experiments, graphene samples were grown by chemical vapor deposition (CVD) and then transferred to proper substrates. We used electron beam lithography and oxygen plasma etching to define graphene rings. The pattered areas were always 3.6 mm wide by 3.6 mm long, much larger than the infrared light beam size used for measurements. IR transmission spectra were measured using a Fourier transform spectrometer at SCM3.

Results and Discussion

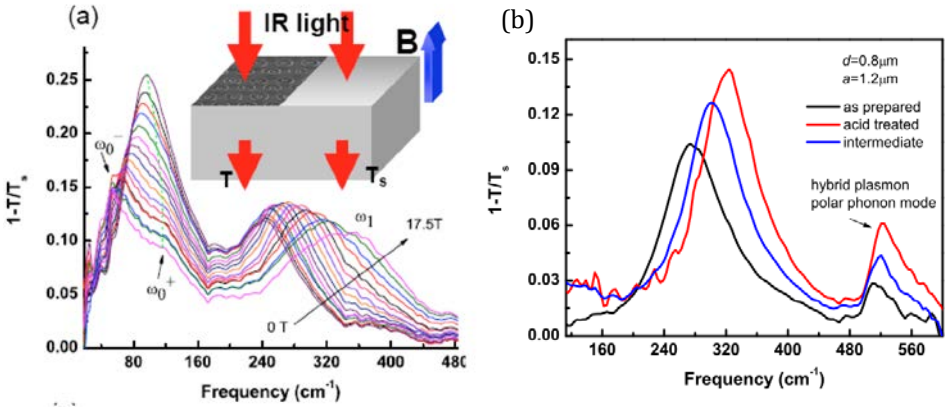

Figure 1: (a) Extinction spectra of a grahene ring array in different magnetic fields. Three modes are indicated. The inset depicts the measurement configuration. (b), The extinction spectra of a graphene disk array at different dopings. The peaks around 500cm^{-1} are due to the hybridization of plasmon mode with a SiO_2 surface polar phonon mode. Data were taken at SCM3 of NHMFL.

Figure 1(a) shows the extinction spectra of a grahene ring array. At zero field, the plasmons in a graphene ring can be assigned to a symmetric (bonding) mode and an anti-symmetric (anti-bonding) mode [2]. These modes stem from the interaction between graphene disks and smaller diameter anti-dots [2]. In finite fields, the bonding mode splits into two modes (ω0- and ω0+ according to their frequencies), while the anti-bonding mode (ω_1) up-shifts and broadens significantly. These new modes are related to edge and bulk magneto-plasmon modes [2]. **Figure 1(b)** depicts the hybridization mode due to plasmon-phonon interactions in graphene disks [2]. Therefore, the data in Figure 1 demonstrates the rich interaction effects associated with plasmons in graphene.

Conclusions

Our magneto-optical measurements [1, 2] have revealed many new insights in the fundamental properties of plasmons in graphene.

Acknowledgements

Part of this work was performed at the National High Magnetic Field Laboratory, which is supported by NSF/ DMR-0654118, the State of Florida, and DOE. The research of ZL is partly supported by UCGP at NHMFL.

References

[1] H. Yan *et al.,* Nano Lett. 12, 3766 (2012).
[2] H. Yan *et al.*, arXiv:1205.6841v1.