IR Spectroscopy of Graphene Nanoribbons Arrays

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Introduction

Graphene plasmons, the collective oscillations of Dirac fermions, have recently attracted a great deal of attention. It has been theoretically suggested that graphene can replace noble metals in future plasmonic devices, as it can host surface plasmons with higher degree of confinement and longer lifetime, owing to its extraordinary material properties. Moreover, recent advances in graphene synthesis and fabrication have made it possible to pattern large-scale μm-sized structures with high carrier mobility and tunable carrier density.

Result and discussion

Using a 17.5T superconducting magnet and Fourier transform infrared spectroscopy we studied light-plasmon coupling in graphene nanoribbon arrays (GNRa). GNR-a with ribbons width of 200nm-100nm and 50nm have been patterned using electron beam lithography techniques, on 2D epitaxial graphene (C-face).

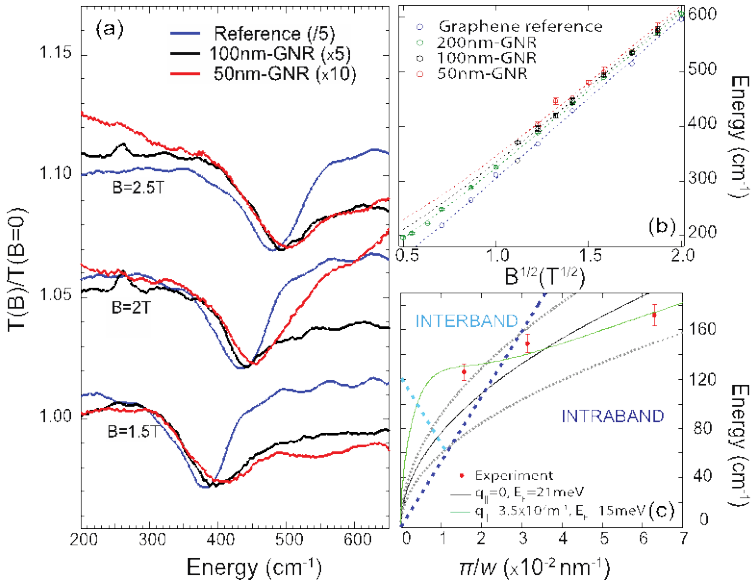

Figure 1. (a) Transmission spectra T_B/T_B=0 for 2D graphene (blue), 50nm (red) and 100nm (black) graphene nanoribbon array at selected magnetic field. The spectra have been measured with un-polarized incoming light (b) Position of the L0(−1) → L1(0) inter LL transition for 50nm (green dot)- 100nm (blue dot) and 200nm (red dot) -GNR-a plus 2D graphene (black circle) versus magnetic field. The dotted line shows the result of the fit using equation (1). (c) ω_{pl} at zero field extracts from (b) plotted versus q = π/W. Full black (green) line: Best fitting using q‖ = 0 (q‖ = 3.4 × 10^7nm−1). Interband and intraband scattering region are delimited by black and blue dashed line respectively.

We report on the observation of the upper-hybrid mode between the plasmon resonance and Landau level transitions in quasi-neutral epitaxial GNR-a [1]. We show that, by studying the magnetic-field dependence of the hybrid mode, one can probe graphene plasmons in the interacting regime, when the coupling to electron-hole excitations results in strong decay of plasmons. For the 100-nm-wide GNR-a, we observe a wavelength shrinkage of λ_{IR} /λ_{pl} ~170, a value difficult to achieve in common plasmonic materials, but in agreement with that predicted for graphene

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Reference

[1] J.M. Poumirol *et al.,* Manuscript in preparation.