Graphene: a new platform for capturing and manipulating light at the nanoscale

Frank Koppens
ICFO, The institute of photonic Sciences, Barcelona (Spain)
frank.koppens@icfo.es

Abstract

In this talk, I will discuss recent experimental and theoretical work on exploiting graphene as a host for capturing, guiding, switching and manipulating light and at nanoscale dimensions. The first part of my talk will be devoted to the emerging and potentially far-reaching field of graphene plasmonics: surface waves coupled to the charge carrier excitations of the conducting sheet. Due to the unique characteristics of graphene, light can be squeezed into extremely small volumes and thus facilitate strongly enhanced light-matter interactions[1]. I will discuss recent observations of propagating and localized optical plasmons in graphene nano-structures [2] (Figure, right panel). By gating the graphene, in-situ control of the plasmon wavelength is demonstrated, which allows us to control the resonance frequency of graphene-based plasmonic cavities. In particular, we demonstrate the capability to completely switch on and off plasmon modes in a graphene ribbon, paving the way towards graphene-based optical transistors.

The second part of the talk is devoted to presenting a novel graphene-based phototransistor with extremely high photo-responsivity and gain [3] (Figure, left panel). The detection mechanism in these devices relies on the photo-gating effect caused by photo-generated charges trapped in quantum dots which decorate the graphene. Due to the combination of high absorption of light in the quantum dots, and the extremely high mobility in the graphene layer, a gain on the order of 10^8 is demonstrated. This highly sensitive photodetector can detect power in the fW regime while covering a broad spectral bandwidth, from the visible to the near infrared, and its responsivity can be tuned by electrostatic gates.

References

[1] Koppens, F. H. L., Chang, D. E. & García de Abajo, F. J. Graphene Plasmonics: A Platform for Strong Light–Matter Interactions. *Nano Lett* **11**, 3370–3377 (2011).
[2] In preparation
[3] Konstantatos, G. *et al.* Hybrid graphene-quantum dot phototransistors with ultrahigh gain. *arXiv* **1112.4730** (2011).

Figures