Hybrid graphene–quantum dot phototransistors for IR-imaging applications

Ivan Nikitskiy[1], A.M. Goossens[1], G. Navickaite[1], J. J. Piqueras[1], G. Konstantatos[1] and F.H. L. Koppens[1]

[1]ICFO – The Institute of Photonic Sciences, Av. Carl Friedrich Gauss 3, 08860 Castelldefels (Barcelona), Spain
ivan.nikitskiy@icfo.es

Abstract

Graphene is an appealing material for optoelectronics and photodetection applications. It has various extraordinary properties, including ultrahigh mobility at room temperature, which enables fast response times. Colloidal quantum dots exhibit unique optical properties of spectral tunability and high absorption coefficients. We combine the favourable electronic properties of graphene with the optical characteristics of colloidal quantum dots to realize a novel hybrid graphene-quantum dot photodetector for visible and short-wave infrared frequencies. [1] The unique electronic properties of graphene offer a gate-tunable carrier density and polarity that enable us to tune the sensitivity and operating speed of the detector.

Here, we exploit this to maximize the photoconductive gain or to fully reduce it to zero, which is useful for pixelated imaging applications, while the implementation of nanoscale local gates enables a locally tunable photoresponse. We also demonstrate our novel approach to fully suppress dark currents in graphene-based photodetectors and increase operation speed of our devices. At the current state our single- and multipixel photodetectors can operate at 30, 60 and up to 90 frames-per-second. The resulting technology is extremely promising for visible and, more importantly, short-wave infrared (SWIR) imaging applications. Sensing and imaging in SWIR range lies at the heart of safety and security applications in civil and military surveillance, night vision applications, automotive vision systems for driver safety, food and pharmaceutical inspection and environmental monitoring.

Operation of a prototype device sensitive to visible and IR light in the auditorium will be demonstrated during the talk.

References

[1] Gerasimos Konstantatos, Michela Badioli, Louis Gaudreau, Johann Osmond, Maria Bernechea, F. Pelayo Garcia de Arquer, Fabio Gatti and Frank H. L. Koppens, Nature Nanotechnology, 7 (2012) 363–368.