Photodetectors based on graphene and hybrid structures

Ivan Nikitskiy[1*], Stijn Goossens[1], Dominik Kufer[1], Shuchi Gupta[1], Frank H.L.Koppens[1,2], Gerasimos Konstantatos[1,2]

[1] *ICFO—Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, Avenida Carl Friedrich Gauss 3, Castelldefels, 08860 Barcelona, Spain.*

[2] *ICREA-Institucio Catalana de Recerca i Estudis Avanc¸ats, Lluis Companys 23, 08010 Barcelona, Spain.*

**ivan.nikitskiy@icfo.es*

The realization of low-cost photodetectors with high sensitivity, high quantum efficiency and fast photoresponse in the visible and short-wave infrared remains one of the challenges in optoelectronics. Graphene and other two-dimensional materials, such as transition metal dichalcogenides, have rapidly proved to be excellent building blocks for photodetectors. These materials have extraordinary electronic properties, including ultrahigh mobility for graphene, and atomically-thin profile. We demonstrated that combining these materials with a good light-sensitizer, such as colloidal quantum dots, creates a new type of ultra-sensitive photodetectors [1,2]. Colloidal quantum dots can offer unique optical properties of spectral tenability and high absorption coefficients. 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. There are two general classes of photodetectors: photodiodes and phototransistors, each of them with specific drawbacks. We managed to merge the two classes in one device by integrating an electrically active colloidal quantum dot photodiode atop a graphene phototransistor [3]. This approach further improves the characteristics of the hybrid photodetectors in terms of speed, quantum efficiency and linear dynamic range. Various prototype devices are being developed to demonstrate the capabilities of this two-dimensional (2D)/0D photodetection technology.

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