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2D (Graphene) –Quantum dot Hybrid photodetector technology for CMOS compatible high performance photodetectors from the UV to Short-wave Infrared.

There is an urgent need for a detector technology platform that concomitantly offers high sensitivity, broad spectral response (from UV to mid-IR), low manufacturing cost and CMOS monolithic integrability. In that respect we will present our recently discovered technology platform for photodetectors enabled by graphene' s high mobility and atomically thin profile and the tailored and high absorption of colloidal quantum dots. Following up to our original report in 2012 [1], where we demonstrated a new hybrid phototransistor architecture covering both UV-Vis and SWIR (short wave infrared) spectral regimes providing exceptionally high gain on the order of 107 and normalized detectivity in the range of 1013 Jones, we will proceed showing some recent results in which the passive sensitizing layer of QDs is transformed into an electrically active QD photodiode. In doing so we report a 4-orders of magnitude improvement in gain-bandwidth product over our first report achieving at the same time responsivity of 106 A/W, electrical bandwidth on the order of kHz and quantum efficiency of up to 75% (thrice higher than what can be achieved through a passive QD layer) [2].
In the second part of the talk we will present results from hybrid 2D-QD photodetectors in which the 2D transistor channel is implemented with a semiconducting 2D transition metal dichalcogenide MoS2 layer [3]. In doing so, we can modulate the transistor reaching very low dark currents and responsivities on the order of 105 A/W . We will discuss advanced interface engineering employed to simultaneously cater for high charge transfer efficiency from the QD layer to the MoS2 layer and maintain the modulation of the MoS2 channel [4].
In the last part of our talk we will briefly present some recent prototypes based on this technology in the field of image sensing and wearable and IOT applications.

References:
[1] Hybrid graphene–quantum dot phototransistors with ultrahigh gain G. Konstantatos, M. Badioli, L. Gaudreau, J. Osmond, M. Bernechea, F. P. Garcia de Arquer, F. Gatti, F. H. L. Koppens Nature Nanotechnol. 7, 363-368 (2012)
[2] Integrating a graphene phototransistor with a colloidal quantum dot photodiode, I. Nikitiskiy et al., Nat. Comm. (2016).
[3] Hybrid 2D–0D MoS2–PbS quantum dot photodetectors D. Kufer, I. Nikitskiy, T. Lasanta, G. Navickaite, F. H. L. Koppens, G. Konstantatos Adv. Mater. 27, 176–180 (2015)
[4] Interface Engineering in hybrid QD-2D phototransistors, D. Kufer et al., submitted.

Summary

We will present our recently discovered technology platform for photodetectors enabled by graphene's high mobility and atomically thin profile and the tailored and high absorption of colloidal quantum dots.

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