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Superfast and sensitive graphene direct and heterodyne detectors for mid-infrared, far-infrared and microwave radiations

Graphene is a fascinating material for optoelectronics due to its broadband light-matter interaction. In this talk, I will discuss our studies of graphene photo-sensors harnessing the hot electron effects. Due to its weak electron-phonon coupling, graphene has the superior capability in retaining the light absorption induced energy transfer within its electronic system. The small electronic heat capacitance subsequently results in an appreciable temperature rise which can be detected electrically. We have developed two versions of graphene hot electron detectors: (1) a cryogenic bolometer that makes use of temperature dependence of graphene resistance; (2) a room-temperature thermoelectric (TE) detector that takes advantage of asymmetric device design to generate a TE voltage. Unlike traditional bolometers that need to be suspended on a spider-web, our graphene bolometer can be made on any substrate since the thermal isolation is between the electrons and the lattice of graphene (Nat. Nanotechnol. 7, 472, 2012). Our graphene TE THz detectors have high intrinsic responsivity and ultrafast response speed (Nat. Nanotechnol. 9, 814, 2014). Through efficient coupling using an antenna and silicon lens, we have further improved the extrinsic responsivity by 2200 times (Nano Lett. 15, 5295, 2015). The fast photo-thermal response (Phys. Rev. Lett. 110, 247402, 2013) makes graphene ideal for broadband heterodyne detection. We have demonstrated recently in the radiofrequency range that graphene mixers have extremely large wide bandwidth exceeding 50GHz.

Biography

Jun Yan has completed his PhD in 2009 from Columbia University in the City of New York. He is currently an assistant professor of physics at the University of Massachusetts-Amherst. He has published more than 20 papers in reputed journals.

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