Ultrasensitive near-infrared photodetectors based on graphene-$MoTe_2$-graphene vertical van der Waals heterostructure

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Abstract

we fabricate graphene-$MoTe_2$-graphene vertical vdWs heterostructure by a site controllable transfer method, and apply it for photodetection from visible to the NIR wavelength range. Compared to the 2D semiconductors photodetectors reported thus far, the graphene-$MoTe_2$-graphene photodetector has superior performance, including high photoresponsivity (~110 mA W−1 at 1064 nm and 205 mA W−1 at 473 nm), high external quantum efficiency (EQE, ~12.9% at 1064 nm and ~53.8% at 473 nm), rapid response and recovery processes (rise time of 24 μs, fall time of 46 μs under 1064 nm illumination), and free from an external source-drain power supply. We have employed scanning photocurrent microscopy to investigate the photocurrent generation in this heterostructure under various back gate voltages and found that the two Schottky barriers between the graphenes and MoTe2 play an important role in the photocurrent generation. In addition, the vdWs heterostructure has a uniform photoresponsive area. The photoresponsivity and EQE of the photodetector can be modulated by the back gate (p^+-Si) voltage. The all-2D-materials heterostructure has promising applications in future novel optoelectronic devices, and may enable next-generation high responsivity, high speed, flexible, and transparent NIR devices.

Figures

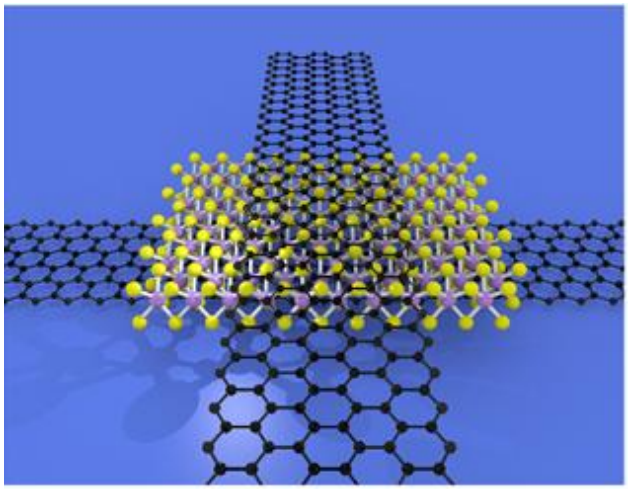

Figure 1: Schematic illustration of the heterostructure.

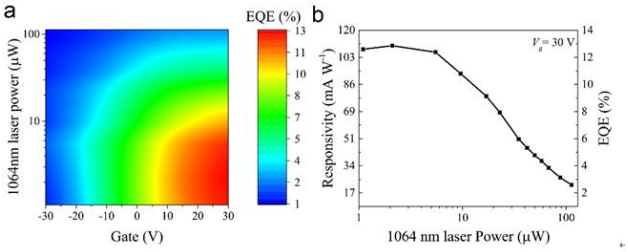

Figure 2: (a) The dependence of EQE on the back gate voltage and incident laser power. (b) The dependence of photoresponsivity and EQE on the incident light power, the back gate voltage is set at 30 V. The photoresponsivity and EQE reach 110 mA W^{-1} and 12.9%, respectively, when the incident power is less than 5 μW.