Supporting Information for

Tin dioxide quantum dots coupled with graphene enabled high-performance bulk-silicon Schottky photodetector

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Figure S1. Schematic diagrams showing the fabrication process of the SnO$_2$-QDs/graphene/Si heterojunction photodetector.

1. CVD growth of graphene
2. Remove SiO$_2$ and expose Si
3. Spin-coating of PMMA
4. Fabricate Au electrode
5. Transfer graphene
6. Spin-coating of SnO$_2$-QDs
Figure S2. (a) Dark $I$-$V$ characteristic of the graphene/Si photodetector. By fitting the $I$-$V$ curve with equation 1, the reverse saturation current ($I_s$) is estimated to be 5.74 µA. As the area of the device is $300\times300\ \mu m^2$, the temperature is 300 K, the effective Richardson constant is $112 \ A\ cm^{-2}\ K^{-2}$, based on equation 2, the Schottky barrier height ($\Phi_b$) is calculated to be 0.19 eV. (b) Dark $I$-$V$ characteristic of the SnO$_2$-QDs/graphene/Si photodetector and fitting with equation 1. The Schottky barrier height ($\Phi_b$) is calculated to be 0.21 eV. (c) $I$-$V$ curves of the graphene/Si photodetector in the dark and under 532 nm light illumination with various light intensities.
Figure S3. Voltage-dependent photocurrent upon illumination with 532 nm light: (a) graphene/Si photodetector; (b) SnO₂-QDs/graphene/Si hybrid photodetector.
Figure S4. Photocurrent evolved with the thickness of the SnO$_2$-QDs film under the same incident intensity (29 $\mu$W/cm$^2$). The graphene/Si device without SnO$_2$-QDs (the thickness of the SnO$_2$-QDs film is 0 nm) is also shown for comparison.
Figure S5. Light intensity dependent external quantum efficiency (EQE) of the graphene/Si and hybrid SnO$_2$-QDs/graphene/Si photodetectors at $V_{ds} = -5$ V.
**Figure S6.** Stability of the SnO$_2$-QDs/graphene/Si photodetector. (a) I-V characteristics of the SnO$_2$-QDs/graphene/Si photodetector before and after exposing to ambient environment for two months. (b) Photoswitching curves of the SnO$_2$-QDs/graphene/Si photodetector before and after exposing to ambient environment for two months.
Figure S7. UV-vis-NIR absorption curve of the SnO$_2$-QDs.

Figure S8. Reflection spectra of the graphene/Si film and SnO$_2$-QDs/graphene/Si film.
Figure S9. The energy band diagrams for graphene and n-Si in the dark and light.