Supporting Information

High-performance near-infrared light photovoltaic detector based on multilayered PtSe$_2$/Ge heterojunction

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Figure S1. Schematic illustration of the procedures for fabrication of PtSe$_2$/Ge heterojunction photodetector.
Figure S2. (a) Raman spectrum of the PtSe$_2$ film. The high resolution XPS spectra of (b) Se 3d and (c) Pt 4f. (d) Raman spectrum of the graphene film. The intensity ratio of $I_{2D}/I_G \approx 2.3$, along with the weak D-band scattering, signifies the high-quality single-layer characteristic of the graphene film.

Figure S3. (a) Schematic illustration of the $I$-$V$ characteristics measurement for (a)
graphene/PtSe$_2$/graphene hybrid, and (c) In/Ga-Ge-In/Ga hybrid. $I$-$V$ curves of (b) graphene/PtSe$_2$/graphene hybrid and (d) In/Ga-Ge-In/Ga hybrid, indicating the formation of good Ohmic contacts.

**Figure S4.** (a) $I$-$V$ curves of PtSe$_2$/Ge heterojunction with different PtSe$_2$ thicknesses in dark and under 1550 nm NIR illumination. (b) $I$-$V$ curves of Au/PtSe$_2$/Au structures with different PtSe$_2$ thicknesses, indicating that the sheet resistance of PtSe$_2$ layers decreases with increase in their thickness.

**Figure S5.** Dark currents of the PtSe$_2$/Ge heterojunction photodetector under different NIR illuminations: Dark 1, 2, 3, 4 denote dark current under 1300, 1550, 1650 and 2200 nm illuminations, respectively.
**Figure S6.** Photoresponse of the NIR detector under pulsed 1550 nm illumination with a frequency of 100 KHz.