# Supporting Information for

## Highly sensitive filterless near-infrared wavelength sensor with two self-driven MLG/Ge heterojunctions

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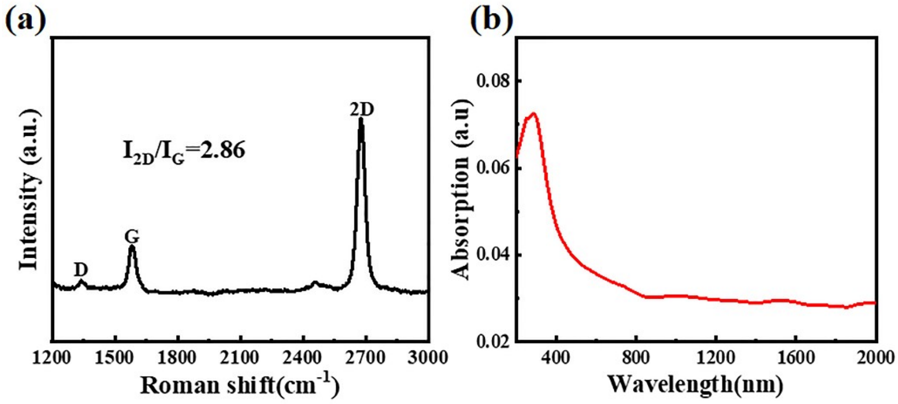


**Figure S1.** (a) Raman spectra of the monolayer graphene(MLG). (b) Absorption curve of the monolayer graphene(MLG).

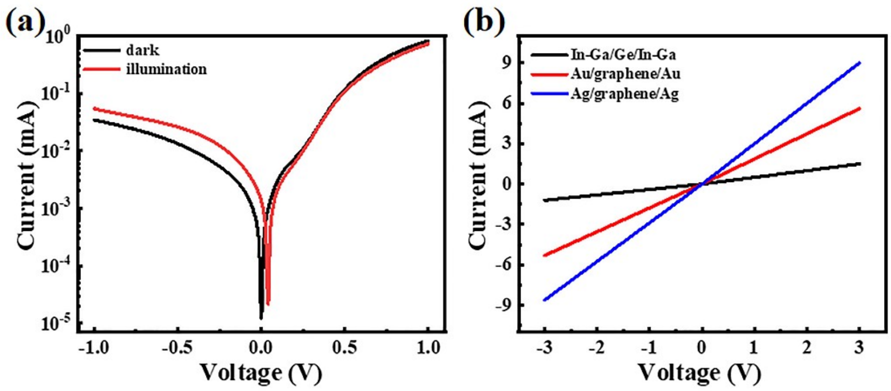


**Figure S2.** (a) Photovoltaic behavior of MLG/Ge heterojunction. (b) *I-V* curves of two Ag-contacted graphene, two Au-contacted graphene, and two In-Ga alloy-contacted Ge, respectively.

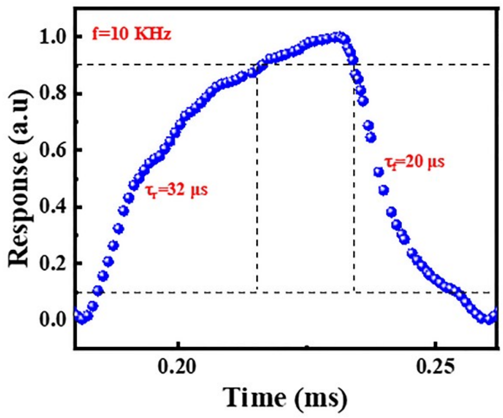


**Figure S3.** A single Normalized cycle was measured at 10 kHz for determining both rise time ($\tau_r$) and fall time ($\tau_f$).

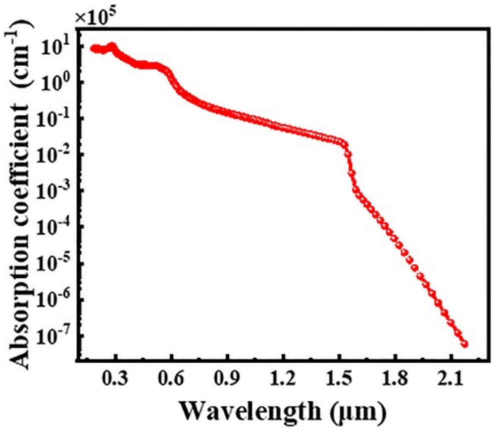


**Figure S4.** The absorption coefficient of n-Ge as a function of wavelength.

The absorption coefficient α of n-Ge is calculated according to the following formula:[1]

$$\alpha = \frac{4\pi k}{\lambda} \quad (1)$$

Where $\lambda$ is the wavelength of incident light, and $k$ is the extinction coefficient of n-Ge. Both of the two parameters can be obtained from the website about refractive index.[2]

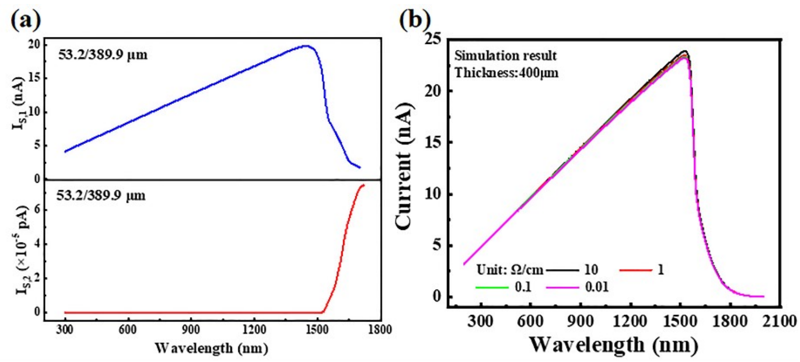


**Figure S5** (a) Smulated photocurrent of PD1 and PD2. (b) Simulated photocurrent with different resistivity.

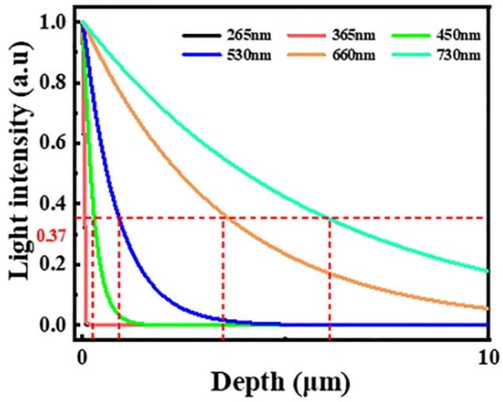


**Figure S6.** Light intensity attenuation curve of Ge.( data extracted from Figure 1c)

**Calculation of the width of the depletion region and diffusion region:**

To quantitatively evaluate the depletion region and neutral region of the MLG/Ge Schottky junction device, depletion region width ($\chi_d$) and carrier diffusion length ($L_n$) could be obtained based on the following formulas: [3, 4]

$$\chi_d|_{V=0} = \chi_{d0} = \sqrt{\frac{2\varepsilon_r\varepsilon_0(V_s)_0}{qN_D}} \qquad (2)$$

$$\frac{(W_s - W_m)}{q} = (V_s)_0 \qquad (3)$$

$$L_n = \sqrt{D_p\tau_p} \qquad (4)$$

$$\frac{D_p}{\mu_p} = \frac{k_0T}{q} \qquad (5)$$

where $\varepsilon_r$ , $\varepsilon_0$ , $V_S$ , $N_D$ , $q$, $W_s$ , $W_m$, $D_p$ , $\tau_p$ , $\mu_p$ , $k_0$ , and $T$ are the relative dielectric constant of semiconductor (Ge: 16), the vacuum dielectric constant ($8.85\times10^{-12}$ F cm$^{-1}$), the contact potential, the doping concentration (Ge: $10^{16}$ cm$^{-3}$), the elementary charge ($1.6\times10^{-19}$ C), the work function of semiconductor (Ge: 4.3 eV), work function of MLG (4.6 eV), the hole diffusion coefficient, the minority carrier life (Ge: $10^4$ μs), the hole mobility, the Boltzmann constant ($1.38\times10^{-23}$ J K$^{-1}$ ), and the temperature (300 K), respectively. What is more, the mobility of $n$-Ge is known to be 1800 cm$^2$ V$^{-1}$ s$^{-1}$, respectively.

**Piecewise fitting functions after considering light intensity:**

Through the analysis of light intensity in **Figure 4c**, the relationship between current ratio and light wavelength at various light intensities can be expressed by the following empirical formula that is obtained by numerical fitting:

$$\lambda = A + \frac{B - A}{1 + e^{\frac{x - C}{D}}} \qquad (6)$$

Where $\lambda$ is the incident light wavelength, and x is the photocurrent ratio. A, B, C, and D are constants that can be affected by the change of light intensity. Furthermore, the numerical relationship between light intensity and coefficients A, B, C，and D are summarized using Boltzmann fitting, through which the following semiempirical equations of light intensity (P) dependent coefficients are achieved:

$$A = 202.573 + \frac{595.704}{1 + e^{\frac{P - 2.535}{0.162}}}, \quad B = 223191.25 + \frac{1087288.75}{1 + e^{\frac{P - 2.122}{0.178}}},$$

$$C = 30599.2 + \frac{5989.806}{1 + e^{\frac{P - 2.269}{0.176}}}, \quad D = 7750.714 - \frac{7350.721}{1 + e^{\frac{P - 2.602}{0.302}}}.$$

By introducing light intensity as a new variable, the equation 5 above can be further rewritten as a new semiempirical equation:

$$\lambda = 202.573 + \frac{595.704}{1 + e^{\frac{P - 2.535}{0.162}}} + \frac{222988.677 + \frac{1087288.75}{1 + e^{\frac{P - 2.122}{0.178}}} - \frac{595.704}{1 + e^{\frac{P - 2.535}{0.162}}}}{1 + e^{\frac{P - 30599.2 - \frac{5989.806}{1 + e^{\frac{P - 2.269}{4066.1160.176}}}}{7750.713 - \frac{7350.721}{1 + e^{\frac{P - 2.602}{0.302}}}}}}$$

(7)

## References


1 M. Grundmann, *Physics of semiconductors*, Springer-Verlag: Berlin, **2010**.

2 https://refractiveindex.info/

3 M. E. Law, E. Solley, M. Liang, D. E. Burk, *IEEE Electron Device Lett.* **1991**, *12*, 401.

4 Q. Guo, A. Pospischil, M. Bhuiyan, H. Jiang, H. Tian, D. Farmer, B. Deng, C. Li, S. J. Han, H. Wang, Q. Xia, T. P. Ma, T. Mueller, F. Xia, *Nano Lett.* **2016**, *16*, 4648.