Supporting Information for

Enhanced broadband photoresponse of substrate-free reduced graphene oxide photodetectors†

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This supporting information includes the following items.

1. Supplementary Fig. S1-8

2. Calculation of effective illuminated area (S), responsivity (R) and external quantum efficiency (EQE)

† Electronic supplementary information (ESI) available. See DOI: 10.1039/xxxx
1. Supplementary Fig. S1-8

**Fig. S1.** (a) Cross-sectional SEM image of the rGO film. (b) Photograph of a Chinese puff pastry.
Fig. S2. (a) Photograph of supported rGO film. (b) The fitting curve between the rGO film thickness and the drop-casting amount of rGO dispersion.
Fig. S3. (a) $I$-$V$ curves of representative supported rGO film device under dark and 532 nm light and (b) locally magnified curves of (a).
Fig. S4. (a) $I$-$V$ curves of representative substrate-free rGO film device under dark and 532 nm light and (b) locally magnified curves of (a).
Fig. S5. Responsivity of the supported and substrate-free devices with 62.5 μm thick rGO film under UV and NIR light irradiation (~ 0.6 W cm\(^{-2}\)). For each illumination, at least 7 different photoresponse periods were measured.
**Fig. S6.** The photoresponse time at the rise edge for the supported and substrate-free devices with 62.5 μm thick rGO film, corresponding to the photoresponse under 375 nm illumination as shown in Fig. 4a.
Fig. S7. The photoresponse time at the rise edge for the supported and substrate-free devices with 62.5 μm thick rGO film, corresponding to the photoresponse under 1064 nm illumination as shown in Fig. 4b.
Fig. S8. Photograph of the rGO film photodetector (left) and SEM image of the area in laser light spot (right). The diameter of laser light spot is about 2 mm.
2. Calculation of effective illuminated area ($S$), responsivity ($R$) and external quantum efficiency (EQE)

To calculated the effective illuminated area, we first found the radio of effective illuminated area of rGO film ($S$) over the whole area of laser light spot ($S_{laser}$). As shown in Fig. S8, this radio can be obtained by pixel extraction

$$\frac{S}{S_{laser}} = 40.26\%.$$

The responsivity ($R$) is calculated as the ratio of photocurrent over the effective light power: $^1, ^2$

$$R = \frac{I_{ph}}{P_{ph} S}$$

where, $I_{ph}$ is the photocurrent ($I_{illumination} - I_{dark}$), and $P_{ph}$ is the illumination power. For example, the responsivity for the substrate-free rGO film device operated in the visible light can be calculated as

$$R = \frac{1.5 \times 10^{-3} A}{0.277 \text{ mW cm}^{-2}(3.14 \times 1 \text{ mm} \times 1 \text{ mm} \times 40.26\%)} = \sim 428 \text{ mA W}^{-1}.$$

The external quantum efficiency (EQE) can be expressed by

$$EQE = \frac{hcR}{e\lambda}$$

where, $h$ is the Planck’s constant, $c$ is the velocity of laser light, $e$ is the electronic change, and $\lambda$ is the exciting wavelength. $^1, ^3$ From our experimental analysis, we can
express the EQE as following:

\[
EQE = \frac{(6.63 \times 10^{-34} J s) \times (3 \times 10^8 ms^{-1}) \times 428 \times 10^{-3} A W^{-1}}{(1.6 \times 10^{-19} C) \times (532 \times 10^{-9} m)} = \sim 100\%
\]

References

1. B. Chitara, L. S. Panchakarla, S. B. Krupanidhi and C. N. Rao, *Adv. Mater.*, 2011, 23, 5419-5424.

2. B. D. Boruah, A. Mukherjee and A. Misra, *Nanotechnology*, 2016, 27, 095205.

3. S. Ratha, A. J. Simbeck, D. J. Late, S. K. Nayak and C. S. Rout, *Appl. Phys. Lett.*, 2014, 105, 243502.