

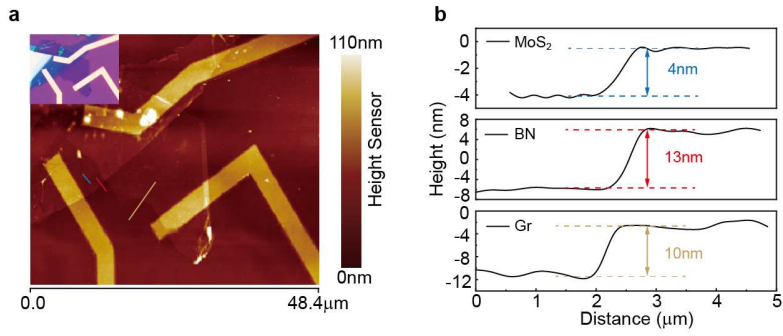
Supplementary Information for

“Tunneling-carrier-controlled sensitive deep ultraviolet photodetector based on van der Waals Heterostructures”

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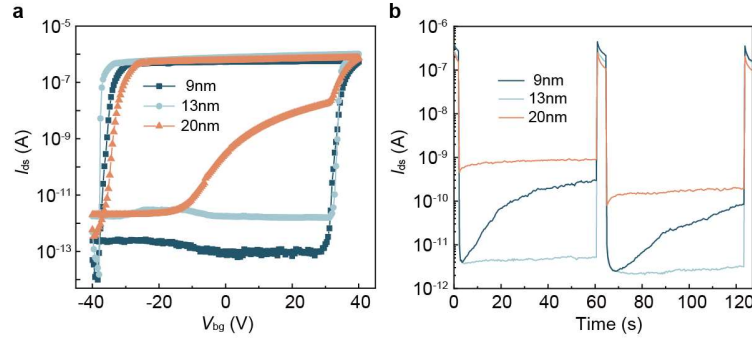
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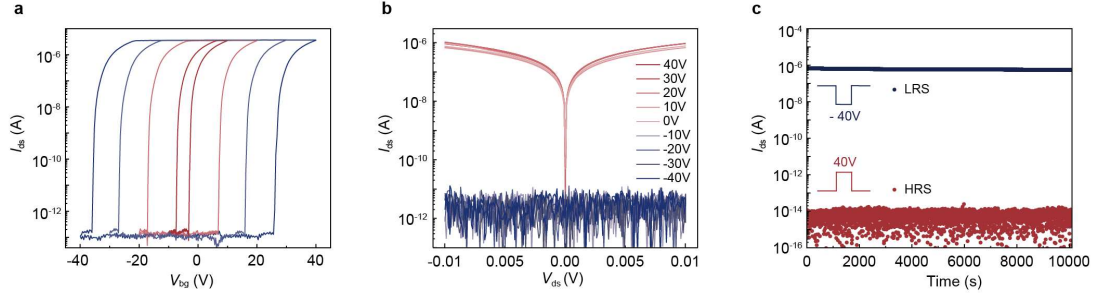
Supplementary Fig. 1 | AFM image and the thickness profile of the heterostructure.

a, AFM image of the device. **b**, the thickness profile of the FLG, hBN, and MoS₂ Layer, showing the thickness of 10 nm, 13nm, and 4 nm, respectively. The device made with these layer materials shows excellent performance.



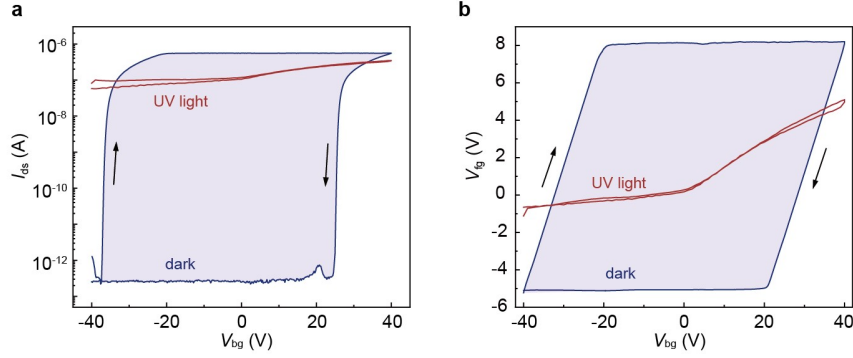
Supplementary Fig. 2 | Characterization of MoS₂/hBN/FLG devices made with different thicknesses of hBN. (a) Transfer curves of the devices with different thicknesses of hBN layer, 9 nm, 13 nm and 20 nm. (b) The HRS stability test in the dark for devices with different thicknesses hBN layer.

As shown in Supplementary Fig. 2, we show the result of devices with three different thicknesses. First, the MoS₂/hBN/FLG device made with a 9-nm-hBN shows a high resistance switching ratio of 10^7 , the dark current at high resistance state (HRS) is as low as 10^{-13} A, which is one magnitude lower than the that made of 12 nm-thick hBN, as shown in Supplementary Fig. 2a. However, the high resistance state of 9-nm-hBN is not easily to be stabilized as shown in Supplementary Fig. 2b. Second, the device made of 20-nm-thick hBN shows a reduced resistance switching ratio when increases the thickness of hBN, therefore the dark current at the HRS is enhanced, which is not beneficial for the photodetection. Therefore, we chose the thickness of 13-nm-hBN which shows a relatively low dark current at HRS and also could be stable for a long time (>10000 s).



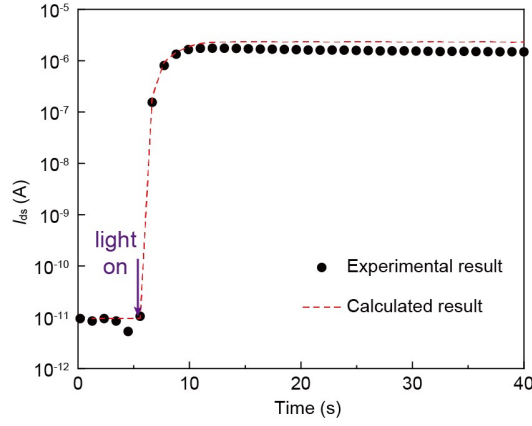
Supplementary Fig. 3 | The resistance switching of the MoS₂/hBN/FLG device. a, Transfer curves of the device under different V_g with sweep ranges. **b,** Output curves under different V_g . **c,** Retention behavior of the high resistance state (HRS) and low resistance state (LRS). The HRS is reached by applying a 40 V V_g pulse, and LRS is reached by applying -40 V V_g pulse.

As shown in Supplementary Fig. 3, the HRS and LRS can be controlled by the V_g pulse, and it could be stabilized for a long time (10000 s). It indicates the charges stored in the FLG layer is stable without light illumination. In other words, the dark current is stable and as low as 10^{-14} A in our tunneling barrier engineered photodetector.



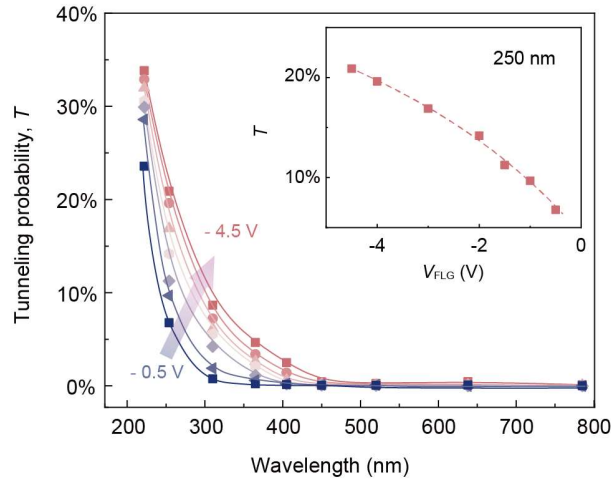
Supplementary Fig. 4 | Transfer curve and FLG potential measured in the dark and under UV light. a. The transfer curve in the dark (blue) and under 254 nm UV irradiation (red). **b.** The potential of the FLG layer during the transfer curve scan. Blue curve corresponds to the darks state, and red curve corresponds to the UV irradiation state.

As it can be seen from Supplementary Fig. 4, the LRS and HRS in the transfer curve move to the same value under 254 nm UV irradiation, indicating both the positive photoresponse (PPR) from the HRS and negative photoresponse (NPR) from the LRS reaches to the same state under UV light. The potential of FLG also changes from -5 V to 0 V during PPR and 8 V to 0 V during NPR process, which is in good agreement with the time resolved measurement of the potential in **Fig. 2i and j** in main text.



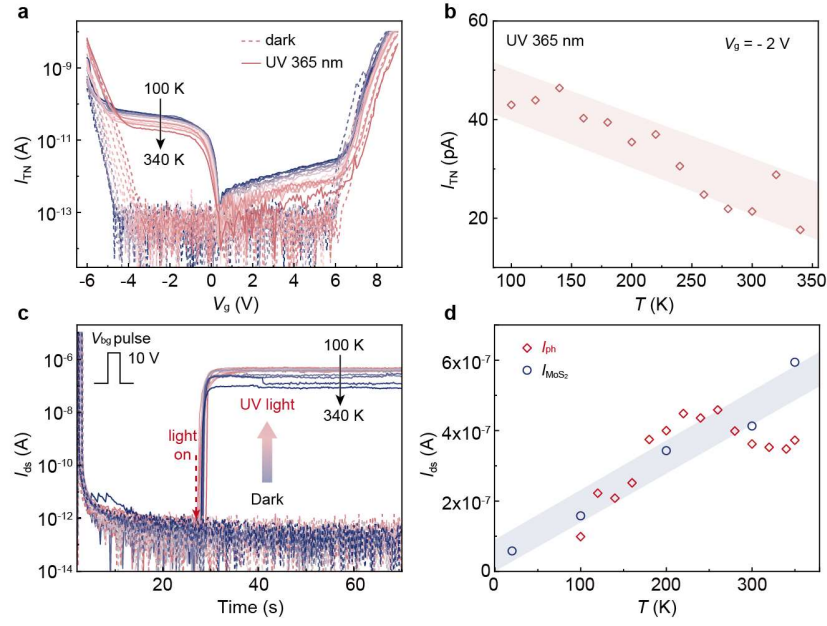
Supplementary Fig. 5 | Photocurrent estimated by capacitance coupling.

The photocurrent (i.e., channel current) is controlled by the capacitance coupling effect between the MoS₂ and FLG layer. When the potential of the FLG layer changes from -5 V to 0 V, it could induce electron accumulation in the channel layer. The photocurrent can be estimated through the detailed calculation using the relations: $\Delta I_{ds} = \Delta n q A_d \mu \cdot E_d$, where Δn represents the change in carrier concentration, expressed as $\Delta n = \Delta Q / V_{\text{MoS}_2}$, $\Delta Q = C_{hBN} \cdot \Delta V_{FLG}$, C_{hBN} refers to the capacitance of hBN, ΔV_{FLG} represents the potential variation of FLG layer under illumination, V_{MoS_2} is volume of MoS₂ channel, q is the elementary charge of an electron, E_d , A_d , and μ are electric field, area, and mobility of MoS₂, respectively. The calculated result matches well with the experimental result, as shown in supplementary Figure 5.

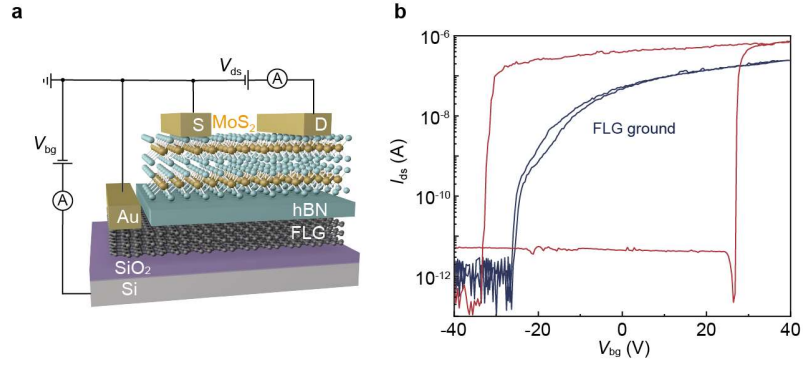


Supplementary Fig. 6 | Tunneling probability at varying electric potential in FLG layer.

As shown in Supplementary Fig. 6, the electron tunneling probability from the FLG layer to MoS₂ layer is influenced by both the wavelength of incident photons and the electric potential of FLG layer. Specifically, a lower potential in the FLG layer cause larger band bending in the hBN layer, therefore enhances the tunneling probability. During the UV photoresponse measurements, the electric potential of the FLG layer gradually increase (as shown in **Fig. 2i**) until it reaches to zero. This increase in potential corresponds with a decrease in electron tunneling probability.

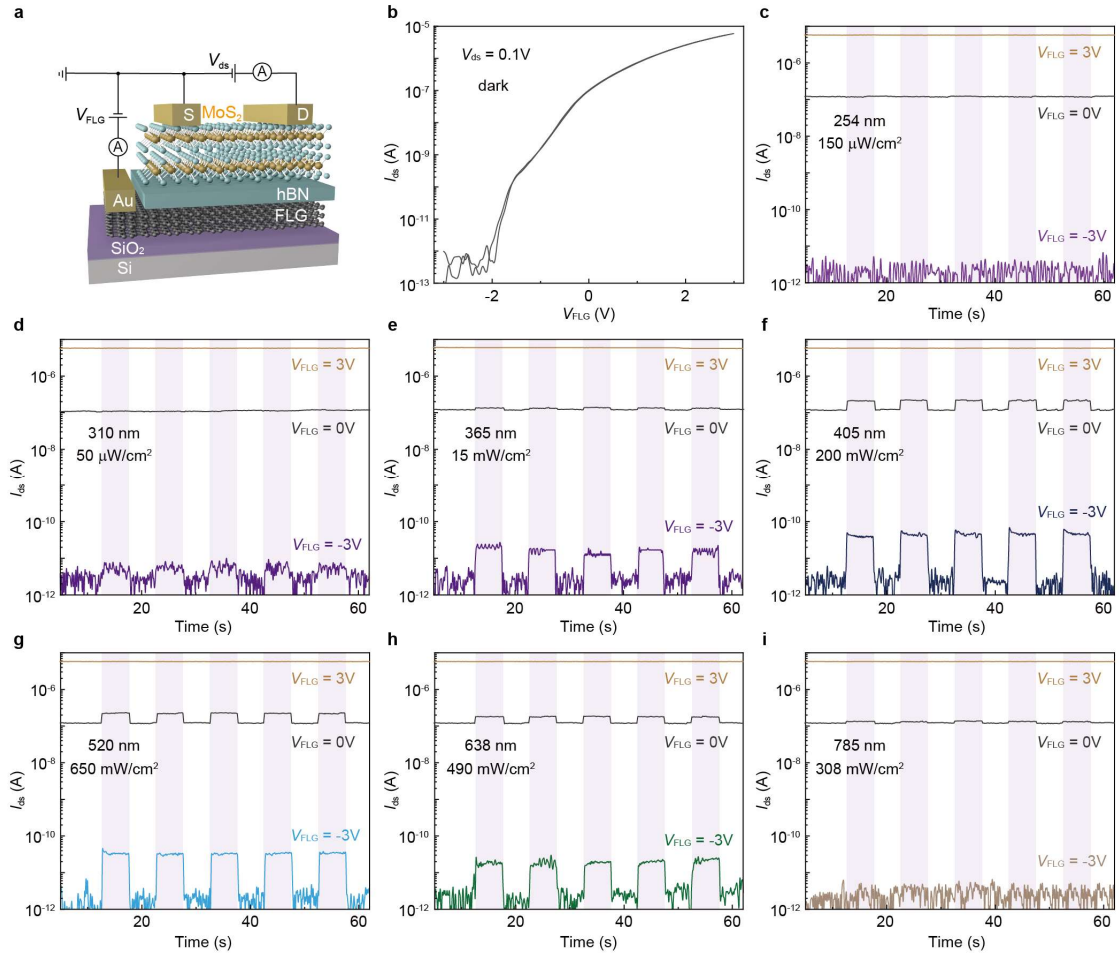


Supplementary Fig. 7 | Temperature dependence of the tunneling current and photoresponse. (a) Temperature dependence of the tunneling current in the dark and under 365 nm UV light. (b) The tunneling current (when $V_g = -2$ V) slightly decreases when increase temperature from 100 K to 340 K. (c) The photoresponse curves under dark and UV illumination conditions at varying temperatures from 100 K to 340 K. (d) The photocurrent slight increases with increasing temperature, which is following the trend of the intrinsic conductivity of MoS₂ materials.



Supplementary Fig. 8 | Transfer curves of the device when FLG is grounded. a, The measurement configuration when FLG layer is grounded. **b,** Comparison of the transfer curves for MoS₂/hBN/FLG device when the FLG layer is grounded (blue curve), and when the FLG is floated (red curve).

As shown in Supplementary Fig. 8b, the transfer curves are distinctly different when the FLG is grounded. It shows almost zero hysteresis of the device, indicating the high quality of the heterostructures with minimum charge traps at the interface. The result also confirmed the function of the FLG in tuning the resistance of the conducting channel.

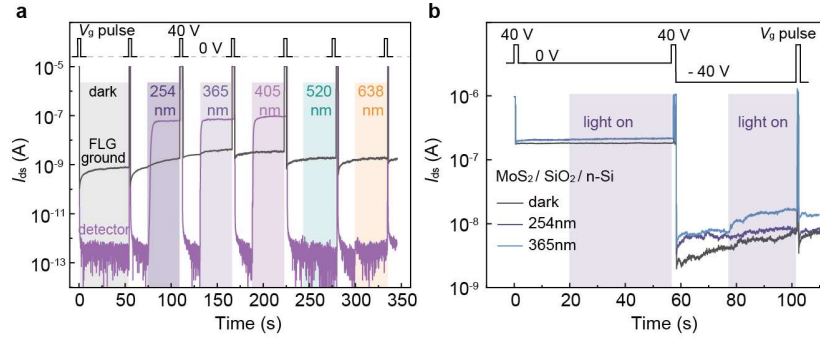


Supplementary Fig. 9 | Photoresponse of the device when V_{FLG} is applied on FLG layer.

a, The measurement configuration when the gate voltage is applied through the FLG layer. **b**, Transfer curves when the gate voltage is applied through the FLG layer. **c-i**, Time-resolved photoresponse of MoS₂ channel when $V_{FLG} = -3$ V, 0 V and 3 V for different wavelength light, (c) 254 nm, (d) 310 nm, (e) 365 nm, (f) 405 nm, (g) 520 nm, (h) 638 nm, (i) 785 nm light.

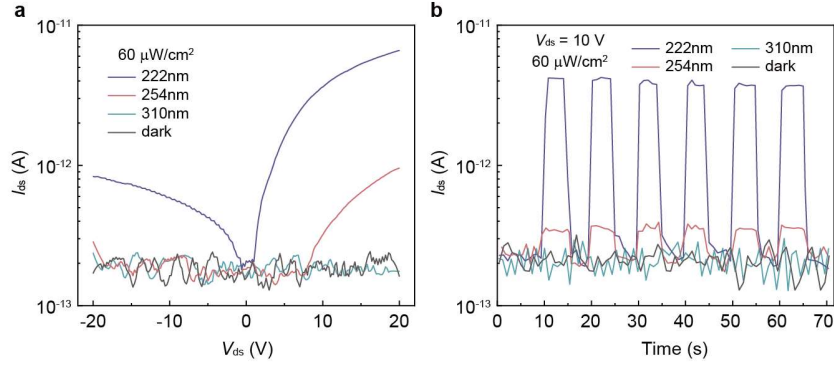
When the V_{FLG} is applied on FLG layer, the MoS₂ channel is tuned to a high resistance state though the hBN dielectric gate. The photocurrent corresponds to the inherent photoelectric effect of MoS₂. It shows a photoresponse until 638 nm, which is consistent with the photon absorption edge of few layered MoS₂. The inherent photocurrent of MoS₂ is very low comparing with photocurrent of MoS₂/hBN/FLG device. And it shows nearly

zero photoresponse for 254 nm UV light. These results suggest the high photoresponse to the UV light is not due to the intrinsic photoelectric properties of MoS₂ layer or hBN layer, but enabled by the charge tunneling between the absorption layer and charge transport layer.



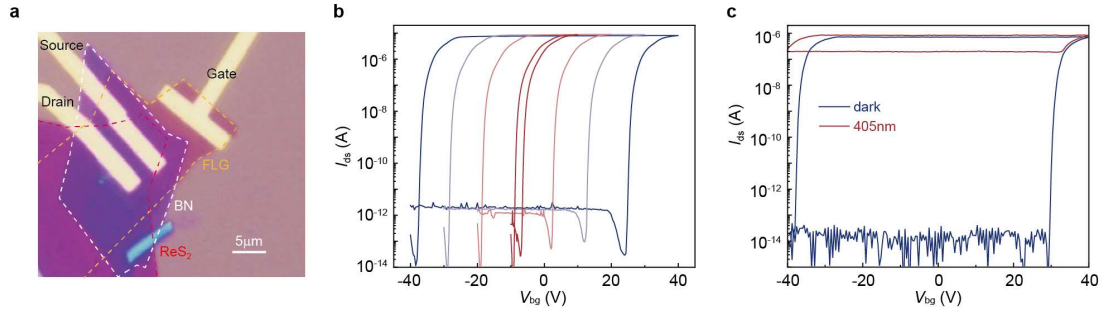
Supplementary Fig. 10 | Photoresponse behavior of MoS₂ transistor on Si/SiO₂ substrate. a, Photoresponse comparison of the MoS₂/hBN/FLG device when FLG layer is floated (magenta curve) and grounded (dark curve) under same light conditions. The light intensity ($P = 1 \text{ mW/cm}^2$) are same for 254 nm, 365 nm, 405 nm, 520 nm and 638 nm light. No clear photoresponse can be observed when FLG layer is grounded. **b,** Photoresponse behavior of MoS₂ transistor on Si/SiO₂ substrate measured in the same condition to the MoS₂/hBN/FLG device. It shows no photoresponse to UV light (254 nm and 365 nm).

The disappeared UV photoresponse of MoS₂ materials when FLG layer is ground (Supplementary Fig. 10a) or removed (Supplementary Fig. 10b), further shows the UV photoresponse in MoS₂/hBN/FLG device is not due to the intrinsic behavior of MoS₂ or the interfacial effect on the Si/SiO₂ substrate.



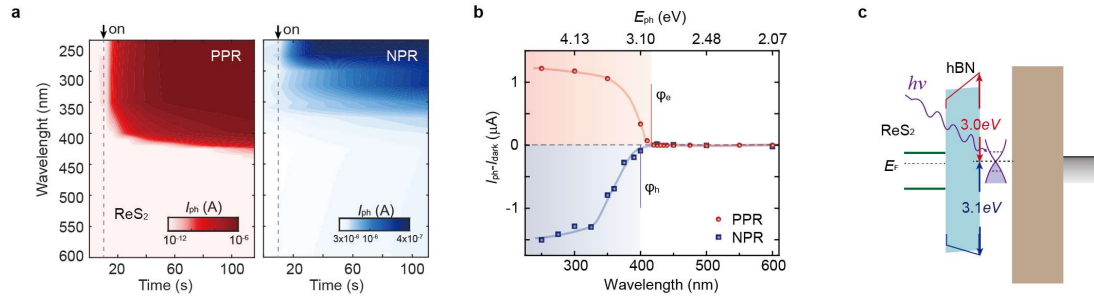
Supplementary Fig. 11 | Photoresponse characteristics of BN device on SiO₂/Si.

(a) I-V output curve; (b) I-T data, measured under a light intensity of 60 $\mu\text{W}/\text{cm}^2$ with wavelengths of 222 nm, 254 nm, and 310 nm. Notably, the conditions at 310 nm did not produce a significant photoresponse.

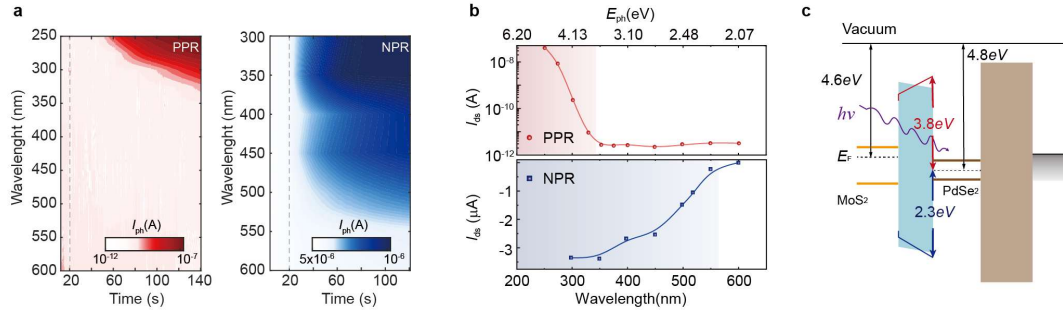


Supplementary Fig. 12 | Transfer curves of ReS₂/hBN/FLG device. **a**, Optical image of the ReS₂/hBN/FLG device. **b**, Transfer curves under different V_g sweep ranges. The hysteresis window is increase with the sweep V_g range. **c**, The comparison of the transfer curve in the dark (blue) and under 405 nm light illumination (red).

As shown in Supplementary Fig. 12, the HRS increase under 405 nm illumination, but the LRS keeps the same under illumination, it is because the 405 nm photon can only assist the electrons overcome the electron tunneling barrier, leading to the PPR, but not large enough to overcome the hole tunneling barrier. It is consistent with the Supplementary Fig. 13. These further confirms the tunneling barrier is important for the spectral response selection.



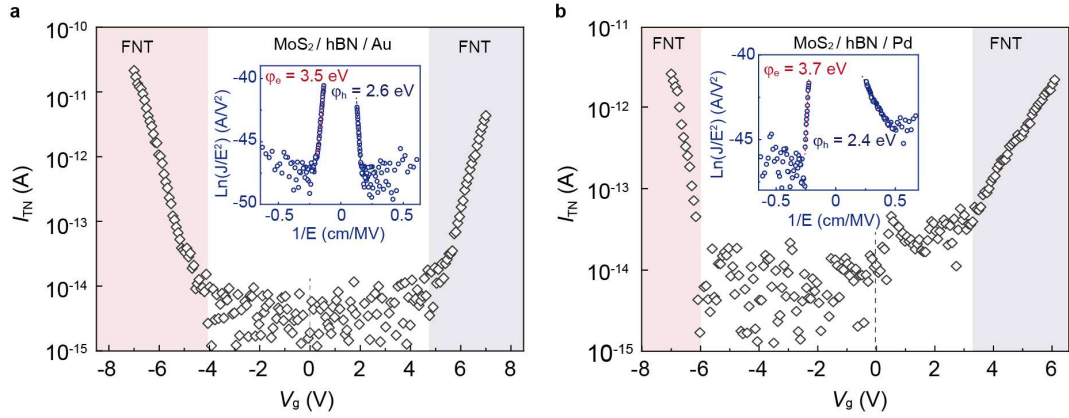
Supplementary Fig. 13 | Spectral response of ReS₂/hBN/FLG photodetector. (a) Contour image plot of PPR and NPR behavior of ReS₂/hBN/FLG device at varying wavelength from 250 nm to 600 nm. Dashed lines indicate the time light is turned on. PPR is measured at $P = 20 \mu\text{W}\cdot\text{cm}^{-2}$, and NPR is measured at $P = 600 \mu\text{W}\cdot\text{cm}^{-2}$. (b) Net photocurrent of ReS₂/hBN/FLG device verse wavelength for both PPR and NPR. ϕ_e and ϕ_h indicated the cutoff photoenergy. (c) Band diagram of the device under PPR and NPR status. Red and blue arrows indicate the electron and hole tunneling barrier of 3.0 eV, and 3.1 eV, respectively.



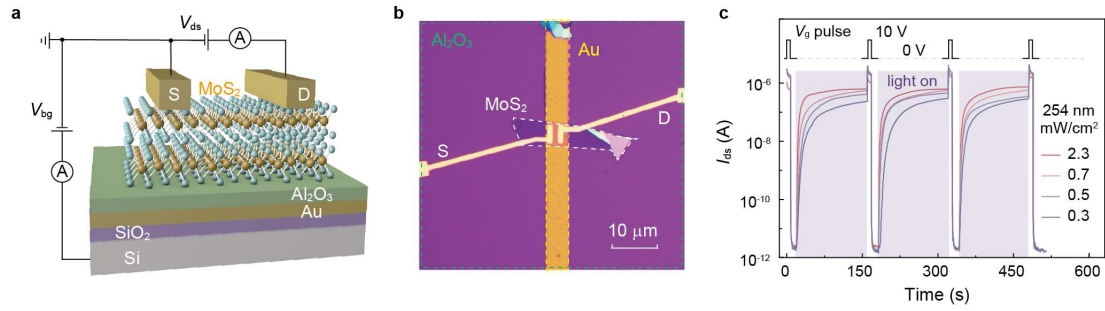
Supplementary Fig. 14 | Spectral response of MoS₂/hBN/PdSe₂ device. **a**, The contour image plot of the PPR and NPR at varying wavelength from 250 nm to 600 nm. **b**, The net photocurrent of the PPR and NPR as a function of wavelength and photon energy. The cutoff energy is about 3.8 eV (ϕ_e) for the PPR, and 2.3 eV (ϕ_h) for the NPR. **c**, The band diagram of the device under PPR and NPR status.

Here we further verify the working mechanism of the tunneling barrier engineered photodetector. We replaced the FLG layer with few layer semiconducting material PdSe₂, which has a lower work function than graphene. As it can be seen in Supplementary Fig. 14, the MoS₂/hBN/PdSe₂ device shows similar PPR and NPR as the MoS₂ and ReS₂ based device. As the work function is lower than FLG, the electron tunneling barrier is larger in MoS₂/hBN/PdSe₂ device, and correspondingly, the hole tunneling barrier is decreased. The sum of the ϕ_e and ϕ_h still equals to 6.1 eV, which is same with the other devices. These results further show the spectral response is determined by the tunneling barrier, and either the charge transport layer or the photon absorption layer can be replaced with other materials. This work presents a universal approach to make high performance photodetector.

It is worthy to note that the tunneling barrier of electron and hole are determined by the difference of the work function as well as the electric field applied on the hBN layer. It is a combined effect of photon assisted tunneling and electric-field assisted tunneling (Fowler-Nordheim (FN) tunneling). Thus, quantitatively calculating the height of tunneling barrier need the support of more experimental results.

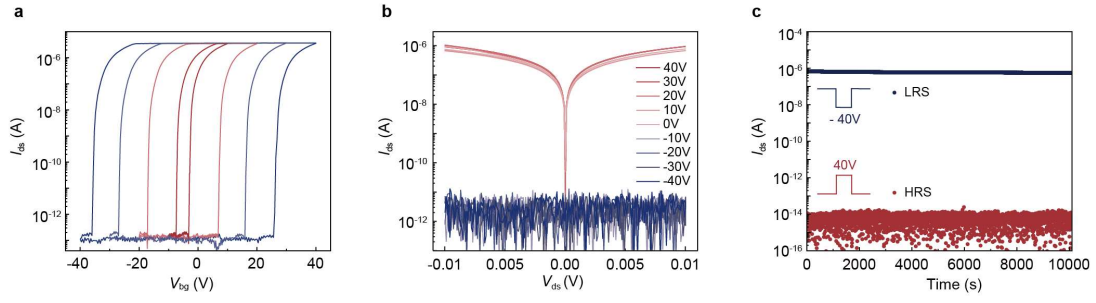


Supplementary Fig. 15 | Tunneling current and tunneling barrier of MoS₂/hBN/Au and MoS₂/hBN/Pd devices. **a**, The tunneling current measurement of MoS₂/hBN/Au device in the dark, and the $\ln(I/E^2)$ vs $1/E$ plot of the tunneling current (inset). The tunneling barrier for electron and hole is calculated to be approximately 3.5 eV and 2.6 eV, respectively, obtaining from the FN tunneling relationship. **b**, The tunneling current measurement of MoS₂/hBN/Pd device in the dark, and the tunneling barrier for electron and hole is calculated to be approximately 3.7 eV and 2.4 eV, respectively.

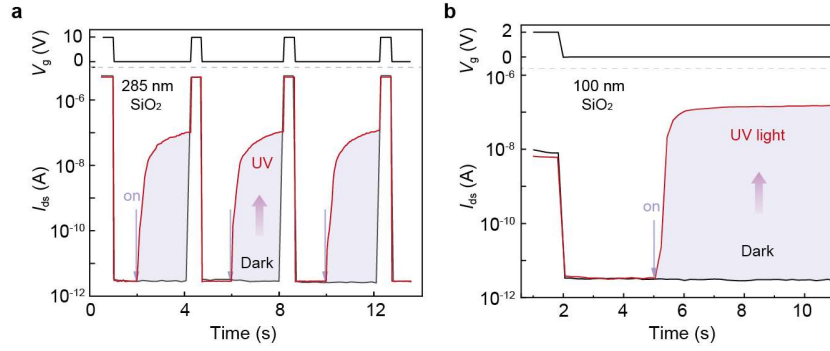


Supplementary Fig. 16 | Photoresponse of MoS₂/Al₂O₃/Au device for 254 nm UV light.

a, schematic diagram of MoS₂/Al₂O₃/Au device on Si/SiO₂ substrate. **b**, The optical microscopic photograph of the MoS₂/Al₂O₃/Au device on Si/SiO₂ substrate. **c**, Photoresponse of MoS₂/Al₂O₃/Au device to 254 nm UV light at varying light intensities, reading voltage is set to 0.1 V, and 10 V V_g pulses are used to reset the detector to a high resistance state.

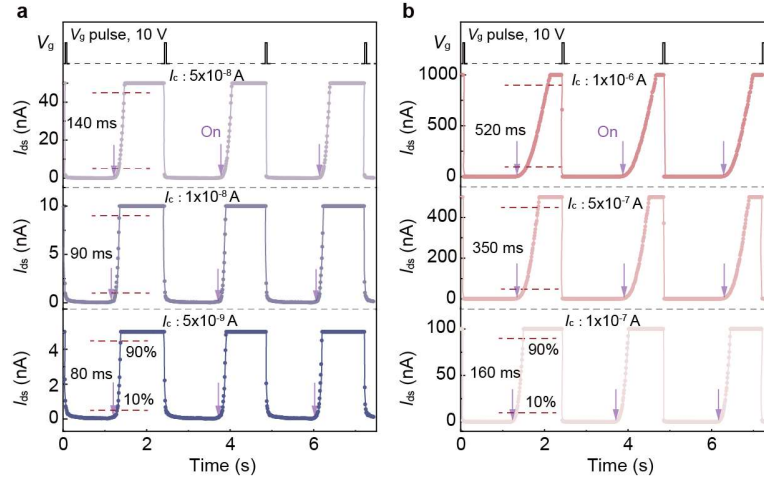


Supplementary Fig. 17 | Photoresponse of MoS₂/hBN/FLG device for other wavelengths. a-c, Time resolved photoresponse for 300 nm (a), 350 nm (b), and 400 nm (c) under different power intensity.

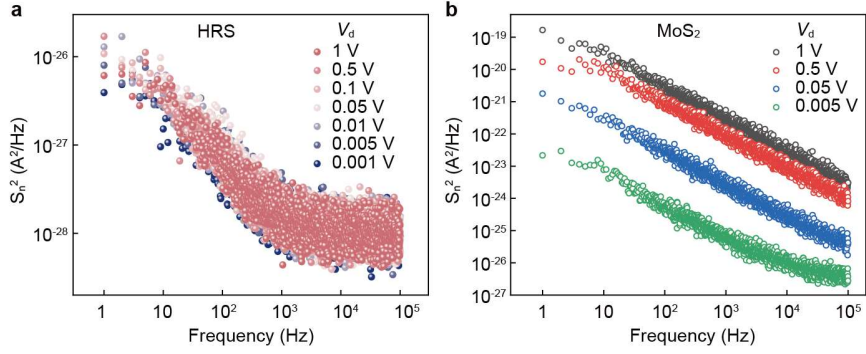


Supplementary Fig. 18 | Photoresponse behavior of the MoS₂/hBN/FLG device measured under different V_g pulses under 285 nm and 100 nm Si/SiO₂ substrate. (a) 10 V V_g pulse is applied to reset the device to high resistance state for devices on 285 nm Si/SiO₂ substrate. **(b)** 2 V V_g pulse is applied to reset the device to high resistance state for devices on 100 nm Si/SiO₂ substrate.

As it can be seen in Supplementary Fig. 18, the reset voltage of V_g pulses can be reduced to as low as 10 V on 285 nm Si/SiO₂ substrate, and further down to 2 V with a 100 nm Si/SiO₂ substrate. This reduction in reset voltage eliminates the need for high-voltage pulses during the operation of the photodetector device, addressing concerns about energy dissipation.

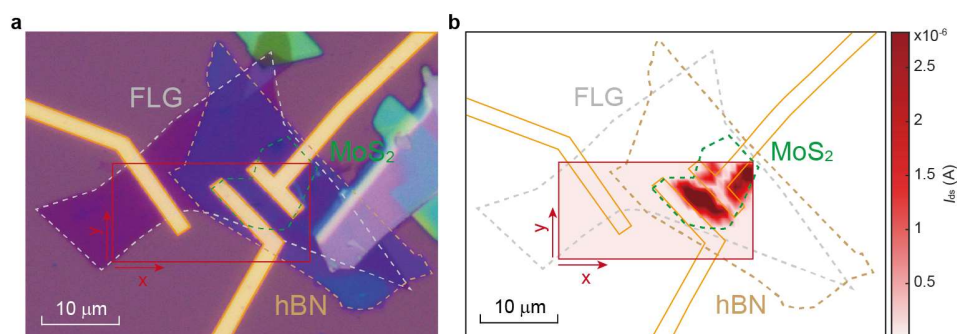


Supplementary Fig. 19 | The modulation relationship between compliance current and response time. By adjusting the compliance current from 5×10^{-9} A to 1×10^{-6} A, the response time can be tuned within a range of 80 ms to 520 ms at 254 nm UV light with an intensity of $120 \mu\text{W}/\text{cm}^2$.

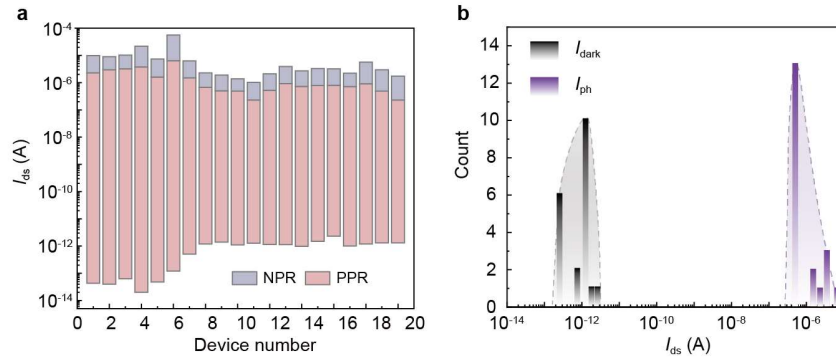


Supplementary Fig. 20 | The Noise spectra at different bias voltage. (a) MoS₂/hBN/FLG (b) MoS₂. The MoS₂/hBN/FLG device is regulated into high resistance state.

As shown in Supplementary Fig. 20a, the noise level is below 10⁻²⁶ (A²/Hz) across different bias voltages ranging from 0.001 to 1 V. Furthermore, the noise level remains relatively unchanged with varying applied bias voltages. For comparison, we also measured the noise spectrum of a single MoS₂ device, which exhibits a relatively higher noise level that increases with applied bias (such as Supplementary Fig. 19b). The MoS₂/hBN/FLG device demonstrates significantly reduced noise, attributed to the negative potential (~ -5 V) in the FLG layer when the device is in a high-resistance state. This negative potential strongly suppresses both the dark current and the noise level.

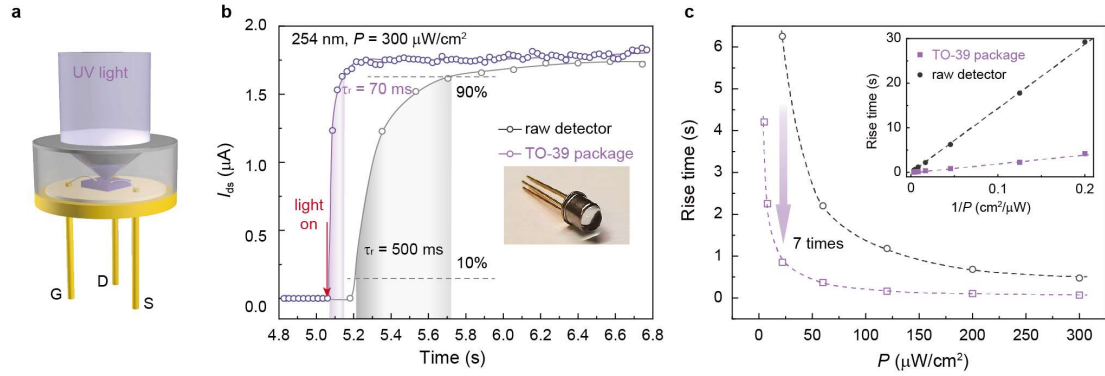


Supplementary Fig. 21 | Photocurrent mapping of the MoS₂/hBN/FLG device. It shows the photocurrent only emerges at the overlapping area between FLG and MoS₂ layer. Therefore, we used the overlapping area to calculate the photoresponsivity and detectivity.

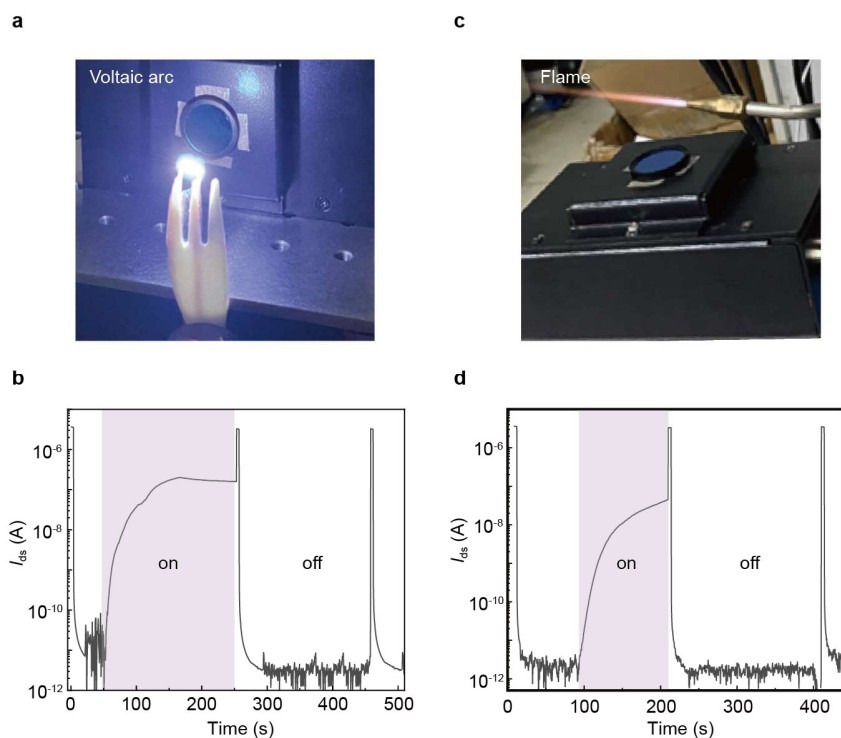


Supplementary Fig. 22 | The statistics of the photocurrent among 20 devices for 365 nm UV light. a, The net photocurrent for PPR and NPR for 20 devices. **b,** the histogram of the photocurrent and HRS current.

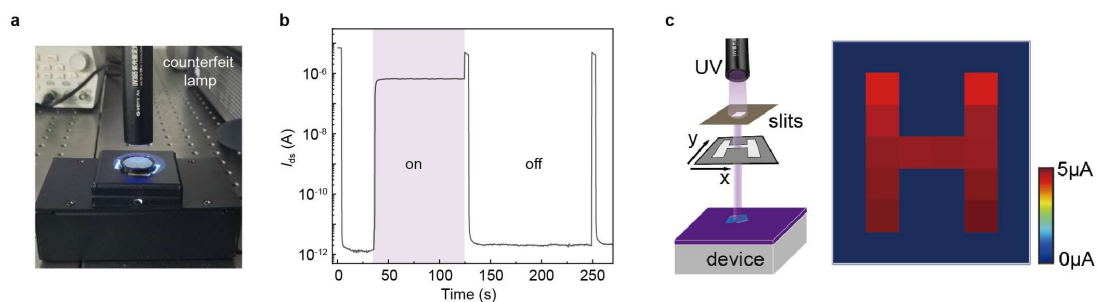
As it is shown in Supplementary Fig. 22, the performance among different devices are quite stable. The on/off ratio of the photoresponse is around 10^6 for most of the devices. It shows the stability of making this heterostructure in the lab.



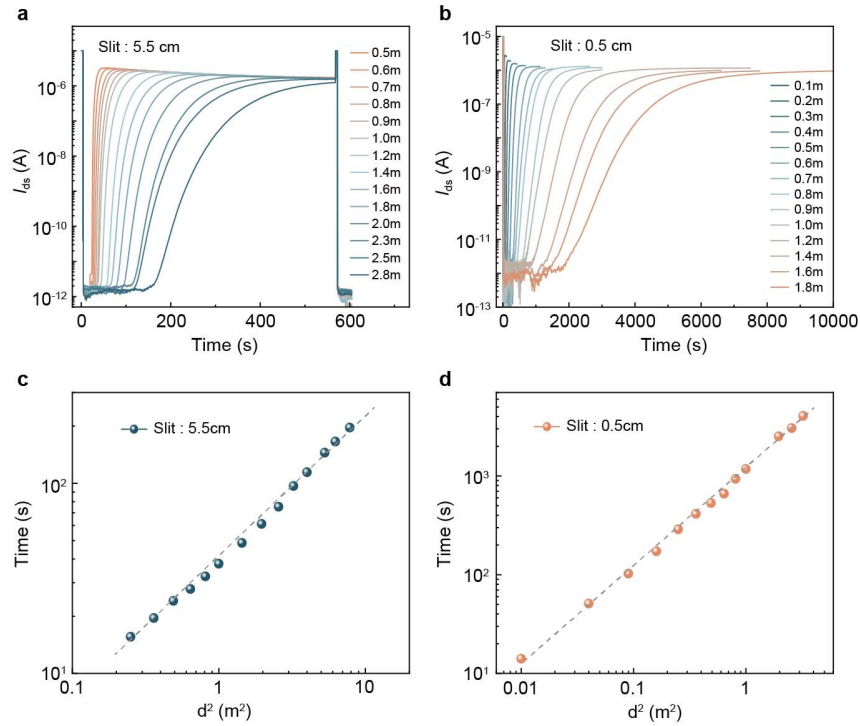
Supplementary Fig. 23 | Packaging the MoS₂/hBN/FLG device using TO-39 with quartz lens. (a) Schematic diagram of the TO-39 package with quartz lens. (b) Photoresponse curve for the MoS₂/hBN/FLG device with and without package under 254 nm light illumination ($P = 300 \mu\text{W}\cdot\text{cm}^{-2}$). The response speed has been clearly improved after TO-39 package. The inset shows a photograph of the TO-39 packaged photodetector. The response time is estimated by measuring the photocurrent increase from 10% to 90% of the saturation current. (c) Comparison of rise time for the device with and without package under varying light intensities. The response time has been shortened by ~ 7 times after the package.



Supplementary Fig. 24 | Photoresponse to the voltaic arc and flame. **a**, Photograph of experimental configuration of measuring the UV irradiation of voltaic arc. **b**, The corresponding photocurrent curve while the voltaic arc is on and off. An UV filter is applied to avoid the impact of the visible light from the voltaic arc. Large photocurrent ($\sim 10^7$ A) can be achieved when the voltaic arc is on. **c**, Photograph of experimental configuration of measuring the UV irradiation of flame. **d**, The corresponding photocurrent curve while the flame is on and off.

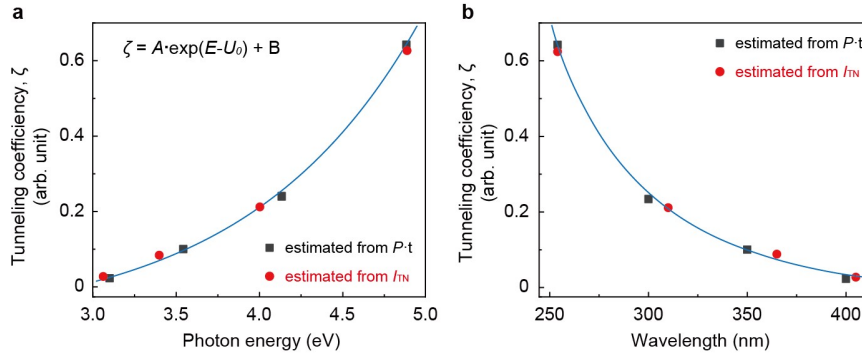


Supplementary Fig. 25 | Photoresponse to the counterfeit detection lamp and UV detection image detection. **a**, Photograph of the experimental configuration of detecting the UV irradiation from counterfeit lamp. The central wavelength of the lamp is 365 nm. **b**, the corresponding photocurrent to the counterfeit lamp while it is on and off. **c**, Schematic presentation of the image system with our device and the image obtained.



Supplementary Fig. 26 | Photoresponse to the 254 nm disinfection lamp. a, Time resolved photocurrent to the disinfection lamp with 5.5 cm slits at varying distance from 0.5 m to 2.8 m. **b,** Time resolved photocurrent to the disinfection lamp with 0.5 cm slits at varying distance from 0.1 m to 1.8 m. **c,** the rising time of the photocurrent verse the square of the detector to lamp distance when slits size is 5.5 cm. **d,** The rising time of the photocurrent verse the square of the detector to lamp distance when slits size is 0.5 cm.

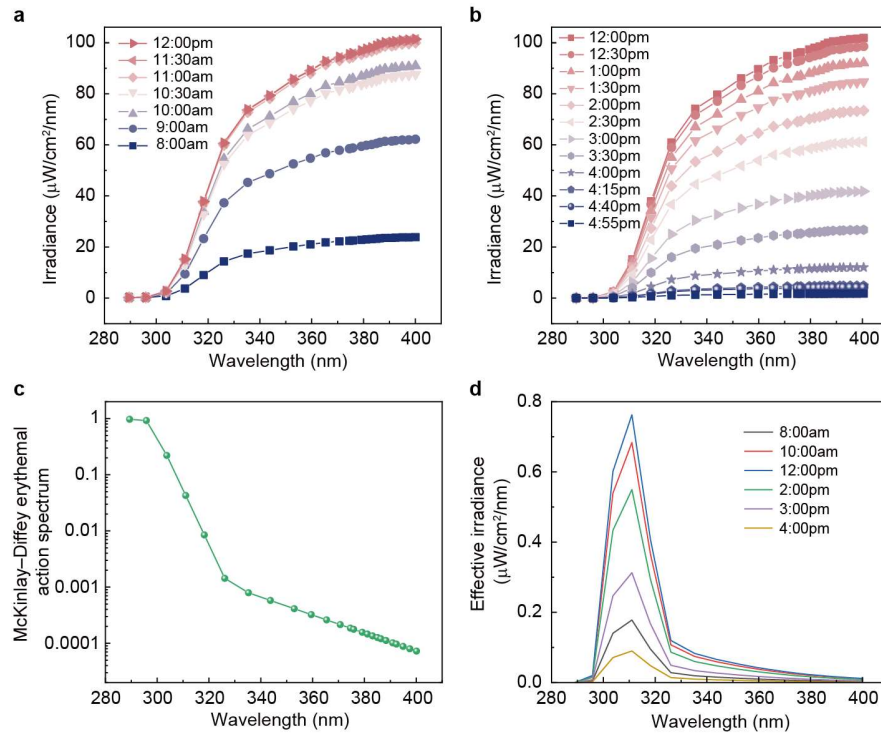
As shown in Supplementary Fig. 26, the rising time of the photocurrent is proportional to the square of the distance between detector and lamp. And the power density of the lamp with 5.5 cm slits was first measured by the commercial UV power meter. Thus, we obtained the inverse proportional relationship between the response time and power density of UV light as shown in **Fig. 5a** in main text. And relying on this relationship, we calculated the power intensity of the lamp with 0.5 cm slits. The obtained power intensity is inverse proportional to the square of the distance d , which is in good agreement to the law of illumination.



Supplementary Fig. 27 | The tunneling coefficient for different incident photons. a, Relationship between the tunneling coefficient and incident photon energy, blue line is fitted curve using the exponential equation $\zeta = A \exp(E - U_0) + B$. **b,** Relationship between the tunneling coefficient and the wavelength of incident light.

The black squares values are estimated from the photoresponse curves of MoS₂/hBN/FLG device. In the device, photocurrent of MoS₂ layer saturates until the charges stored in the FLG layer are completely excited and tunneling out, that is the potential of FLG layer reaches zero, as shown in **Fig. 2i**. In this process, the product of the rising time (t) and light intensity (P) is a constant, which is determined by the number of charges stored in the FLG layer and the tunneling coefficient of the electrons. Therefore, the tunneling coefficient is proportional to the inverse of $P \cdot t$ values for different wavelength. The red dot values are estimated from the electron tunneling current measurements (**Fig. 3c**). Considering the dependency of the electron tunneling probability on electric potential of FLG layer, the total tunneling coefficient is integrated over the V_{FLG} range from (-4.5 V to 0 V), corresponding to the gradually increase of the potential in FLG layer 0 V.

Both the tunneling coefficient values for varying photon energies are well fitted by the exponential function $\zeta = A \exp(E - U_0) + B$ (Supplementary Fig. 25), suggesting their good consistency.



Supplementary Fig. 28 | The calibrated UV spectrum of solar from 8 am to 5 pm. a, The UV spectrum of sunlight from 8 am to 12 pm. **b,** The UV spectrum of sunlight from 12 pm to 5 pm. **c,** CIE-standard McKinlay–Diffey erythemal action spectrum, which represents of the erythema-inducing effectiveness of wavelengths in the UV part of the spectrum. **d,** The effective UV irradiance at different time, obtained from the product of the UV irradiance spectrum and erythemal action spectrum.

Supplementary table

Supplementary table 1| Comparison of performance with other UV detectors

Device (Material)	λ (nm)	bias (V)	P($\mu\text{W}\cdot\text{cm}^{-2}$)	R ($\text{A}\cdot\text{W}^{-1}$)	D (Jones)	on/off ratio	I_{dark} (A)	Rise time	Fall time	Reference
MoS ₂ /hBN/FLG	254	0.8	1	4.4×10^6	1.4×10^{17}	10^6	1×10^{-12}	210s (30s)	<0.1ms	This work
	254	0.8	20	2.4×10^5	7.3×10^{15}	10^6	1×10^{-12}	6s (0.85s)	<0.1ms	Raw device (Packaged device)
	254	0.8	300	1.6×10^4	5.1×10^{14}	10^6	1×10^{-12}	0.5s (70ms)	<0.1ms	
TiO ₂	260	5	15	889.6	-	-	1.8×10^{-9}	13ms	11s	<i>Appl. Phys. Lett.</i> 94 , 123502(2009)
p-CuZnS/n-TiO ₂ NTAs PD	350	3	-	640	-	-	-	-	-	<i>Adv. Mater.</i> 30 , 1803165(2018)
SiC	280	-	10^4	0.2	4.8×10^{12}	1215	-	-	-	<i>Electron. Lett.</i> 59 , 12953(2023)
AlN-SiC	265	-50	-	-	1×10^{15}	-	1×10^{-14}	-	-	<i>Appl. Phys. Lett.</i> 90 , 263505(2007)
Ga ₂ O ₃ /SiC	254	-5	70	0.18	-	63	5.1×10^{-10}	0.65s	1.73s	<i>J. Alloys Compd.</i> 680 , 247 (2016)
a-GaOx	250	10	70	70.26	1.26×10^{14}	10^5	3.4×10^{-10}	0.41s	0.02s	<i>ACS Photonics</i> 4 , 2203 (2017)
GaN/Ga ₂ O ₃	254	0	500	3.05	1.69×10^{13}	10^4	1.8×10^{-11}	18ms	148ms	<i>ACS Nano</i> 12 , 12827 (2018)
GR a-GaOx	254	12	10^3	66.7	8×10^{15}	10^5	4.6×10^{-14}	80ms	-	<i>Adv. Mater.</i> 34 , 2106923(2021)
Graphene/Ga ₂ O ₃ /Al ₂ O ₃ /Al	254	10	8	295	1.7×10^{15}	9×10^4	1.6×10^{-11}	1.7s	26.8s	<i>Nano Res.</i> 15 , 3711 (2021)
Graphene/ β -Ga ₂ O ₃	254	20	315	39.3	5.92×10^{13}	-	1.1×10^{-6}	-	-	<i>Adv. Mater.</i> 28 , 10725 (2016)
amorphous Ga ₂ O ₃ PD	270	5	75	9.7	2×10^{12}	-	1.5×10^{-6}	1s	1.1s	<i>ACS Appl. Electron.</i> 11 , 2463 (2019)
Diamond	220	0	11	0.016	5.2×10^{13}	-	7×10^{-15}	-	-	<i>ACS Appl. Electron. Mater.</i> 4 , 5996 (2022)
NiO/diamond	220	30	-	0.022	1.47×10^{10}	57	5.9×10^{-7}	-	-	<i>Appl. Phys. Lett.</i> 112 , 032103(2018)
ZnO	365	5	108	27	8.5×10^{13}	-	4.5×10^{-8}	78 μ s	60 μ s	<i>Appl. Surf. Sci.</i> 481 , 437 (2019)
ZnO PD	360	15	500	2.2	-	10^2	1×10^{-8}	0.2s	0.3s	<i>J. Appl. Phys.</i> 125 , 024502(2019)
ZnO nanowire PD	365	5	1	4.3	-	10^3	-	12s	230s	<i>IEEE Sens. J.</i> 18 , 7881 (2018)
amorphous InGaZnO PD	400	20	66	3.6×10^4	4.43×10^{12}	10^3	7.1×10^{-6}	-	-	<i>IEEE Electr Device L.</i> 40 , 1646 (2019)
MoS ₂	637	1	-	16.8	1.06×10^{13}	10^5	1×10^{-11}	38ms	24ms	<i>Adv. Opt. Mater.</i> 8 , 1901402(2020)
AlGaN/GaN	310	4	-	4.5	6.19×10^{11}	-	-	-	-	<i>Sci. Rep.</i> 10 , 22059(2020)
AlGaN/GaN 2DEG-IPD	365	-5	4×10^3	1670	-	3×10^4	3.8×10^{-9}	0.05s	0.36s	<i>ACS Nano</i> , 15 , 8386 (2021)
GaN self-powered PD	UV	0	3×10^4	0.03	1.78×10^{12}	3×10^4	3.5×10^{-11}	-	-	<i>ACS Nano</i> . 10 , 1572 (2016)
MoS ₂ /g-C ₃ N ₄ hybrid PD	365	-9	5×10^5	0.5	4×10^{11}	10^4	1×10^{-9}	0.06s	0.1s	<i>Adv. Funct. Mater.</i> 27 , 1605554(2017)
CsPbBr ₃ perovskites PD	450	1	2×10^3	0.0029	10^{10}	10^3	4.8×10^{-8}	0.26s	0.28s	<i>Nanoscale</i> , 11 , 2871 (2019)
SnS nanoflake PD	380	5	3×10^4	3×10^{-6}	-	27	5×10^{-10}	0.67s	0.52s	<i>RSC Adv.</i> 6 , 114980 (2016)