Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Ultrahigh Photoresponsivity UV Photodetector Based on BP/ReS_2 Heterostructure p-n Diode

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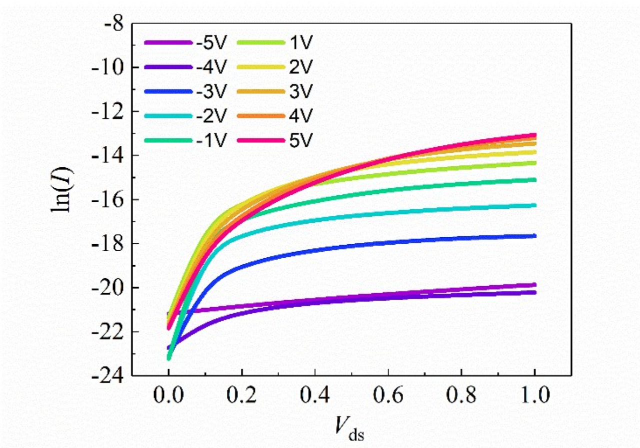

Figure S1 The ln(I) *versus* V_{ds} plot for extracting the device ideality factor.

The diode ideality factor can be calculated from a plot of the logarithmic output characteristics at the forward bias based on the following equation:

$$I = I_{sat}\left[exp\left(\frac{qV}{nk_BT}\right) - 1\right]$$

Where I is the diode current, V is the applied voltage, I_{sat} is reverse saturation current, n is the ideality factor, T is the temperature, q is elementary charge, and k_B is the Boltzmann's constant. For voltage greater than a few k_BT (e.g., > 0.1V), the " − 1" term in the above equation can be equation gives the following equation:

$$\ln (I) = \ln (I_{sat}) + \left(\frac{q}{nk_BT}\right)V$$

When plotting the natural logarithm of the diode current *versus* the applied voltage based on the above equation, the slope gives q/nk_BT.

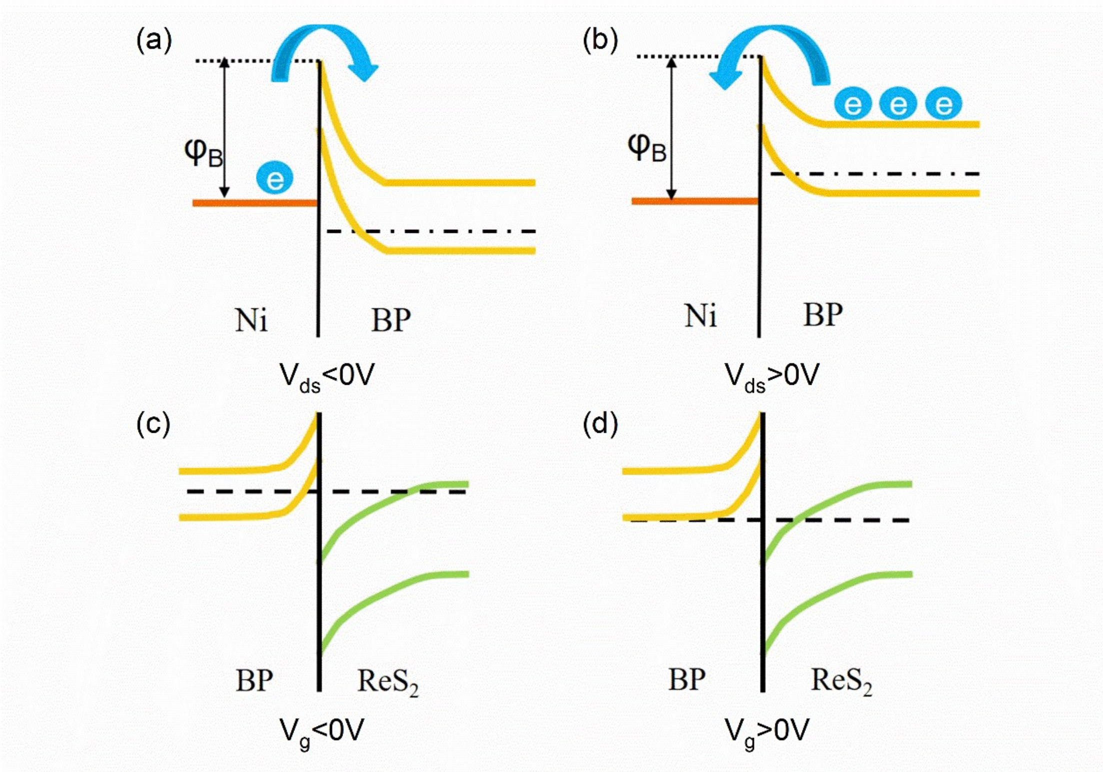

Figure S2 Energy band diagrams of the Ni/BP junction at (a) negative and (b) positive bias voltage. Schematics of the band alignments when (c) negative and (d) positive back gate voltage is applied.

Table S1. Comparison of the key parameters of our device to the reported BP and ReS_2-based photodetectors.

Material	Measurement condition				Responsivity	Reference
	V_{ds} (V)	V_g (V)	λ (nm)	P	R (A/W)	
ReS_2/MoS_2	2	0	532	30.6 μW/cm^2	35.07	1
ReS_2	1	0	532	0.56 mW/cm^2	0.98	2
ReS_2 hexagon	0.5	0	500	3.11 mW/cm^2	604	3
ReS_2(lateral PN)	-2	0	660	3.11 mW/cm^2	0.14	4
ReS_2(O_2-plasma)	5	30	405	5 pW	2.5×10^7	5
ReS_2	2.1	50	633	25 nW	16.14	6
ReS_2	4	-50	532	6 pW	88600	7
BP-on-WSe_2	0.5	0	637	1 mW/cm^2	10^3	8
BP/MoS_2	3	0	532	1 nW	22.3	9
BP/MoS_2	2	0	633	1 μW	3.54	10
BP	0.3	-4	3390	16.5 W/cm^2	82	11
BP/OTS	-0.1	-40	520	0.5 mW/cm^2	1.4×10^4	12
WS_2/BP	5	0	532	44.2 mW/cm^2	120m	13
BP/Graphene	1	0	1550	11 nW	3.3×10^3	14
BP/ReS_2	1	0	365	0.55 mW/cm^2	4120	This work

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