Electronic Supplementary Material (ESI) for Nanoscale.

Ultrasensitive and fast monolayer WS_2 phototransistors realized by SnS nanosheet decoration

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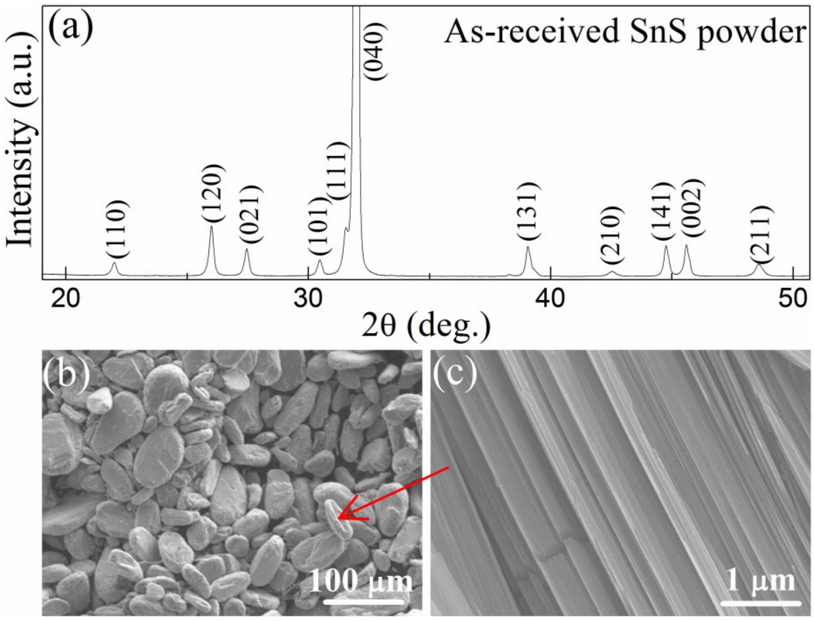

Figure S1. (a) XRD pattern of as-received SnS powder at room temperature. (b) SEM image at low magnification. (c) SEM image at high magnification.

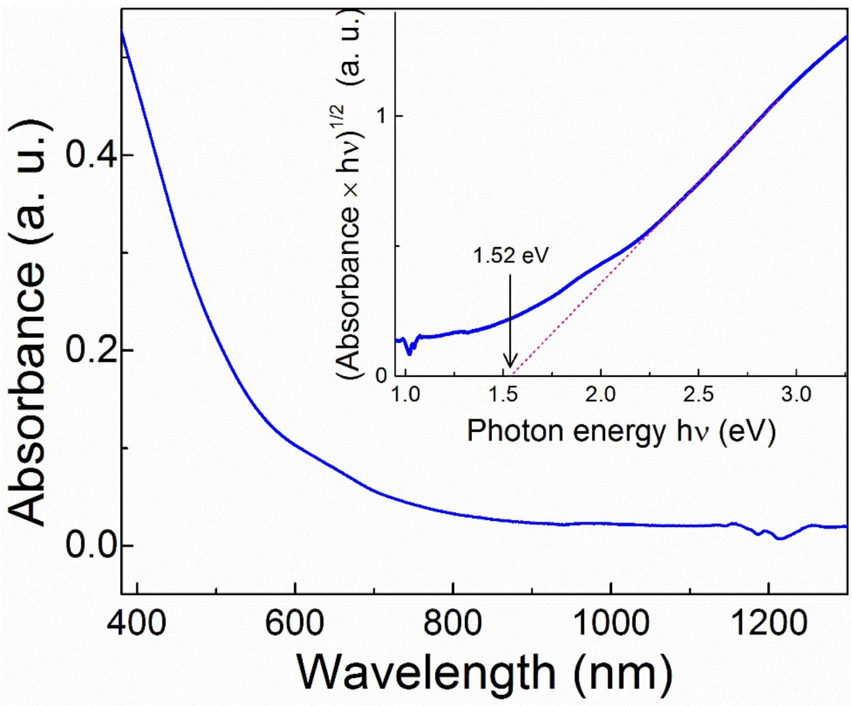

Figure S2. Absorption spectrum of the liquid-phase exfoliated alcohol dispersion of SnS nanosheets. Inset is the Tauc plot, where the downward arrow demonstrated the position of the indirect bandgap.

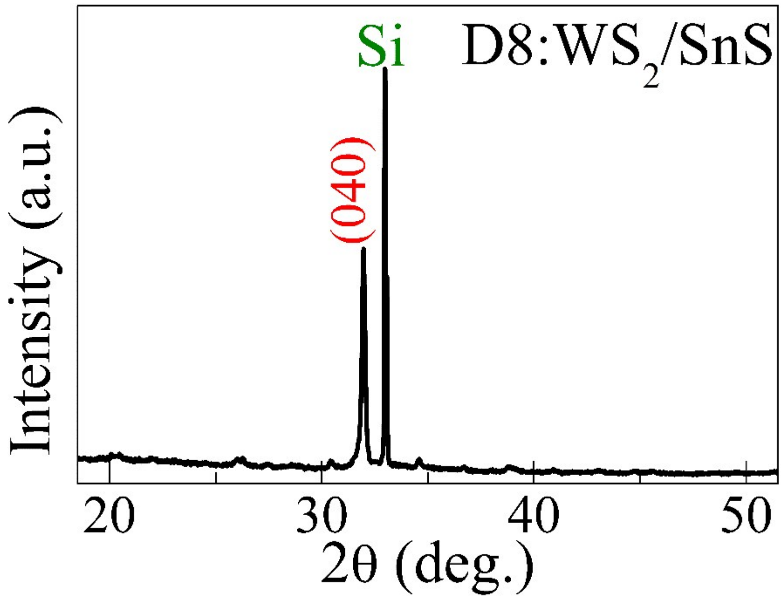

Figure S3. XRD pattern of the decorated WS_2 monolayer channel with SnS NSs in the decorated D8 device.

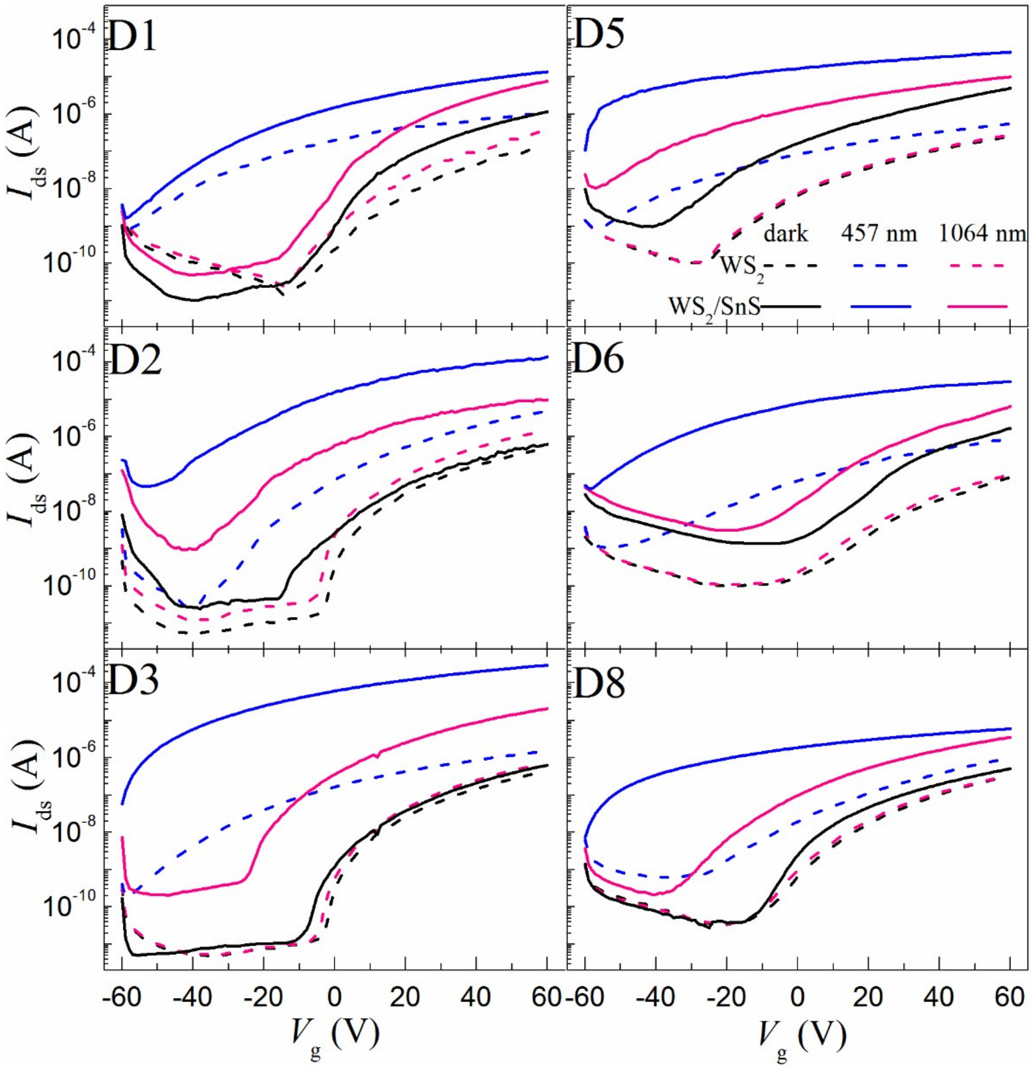

Figure S4 Tranfer curves at V_{ds}=5 V for the decorated Dn and pure WS_2 devices under dark and illumination of 457 and 1064 nm.

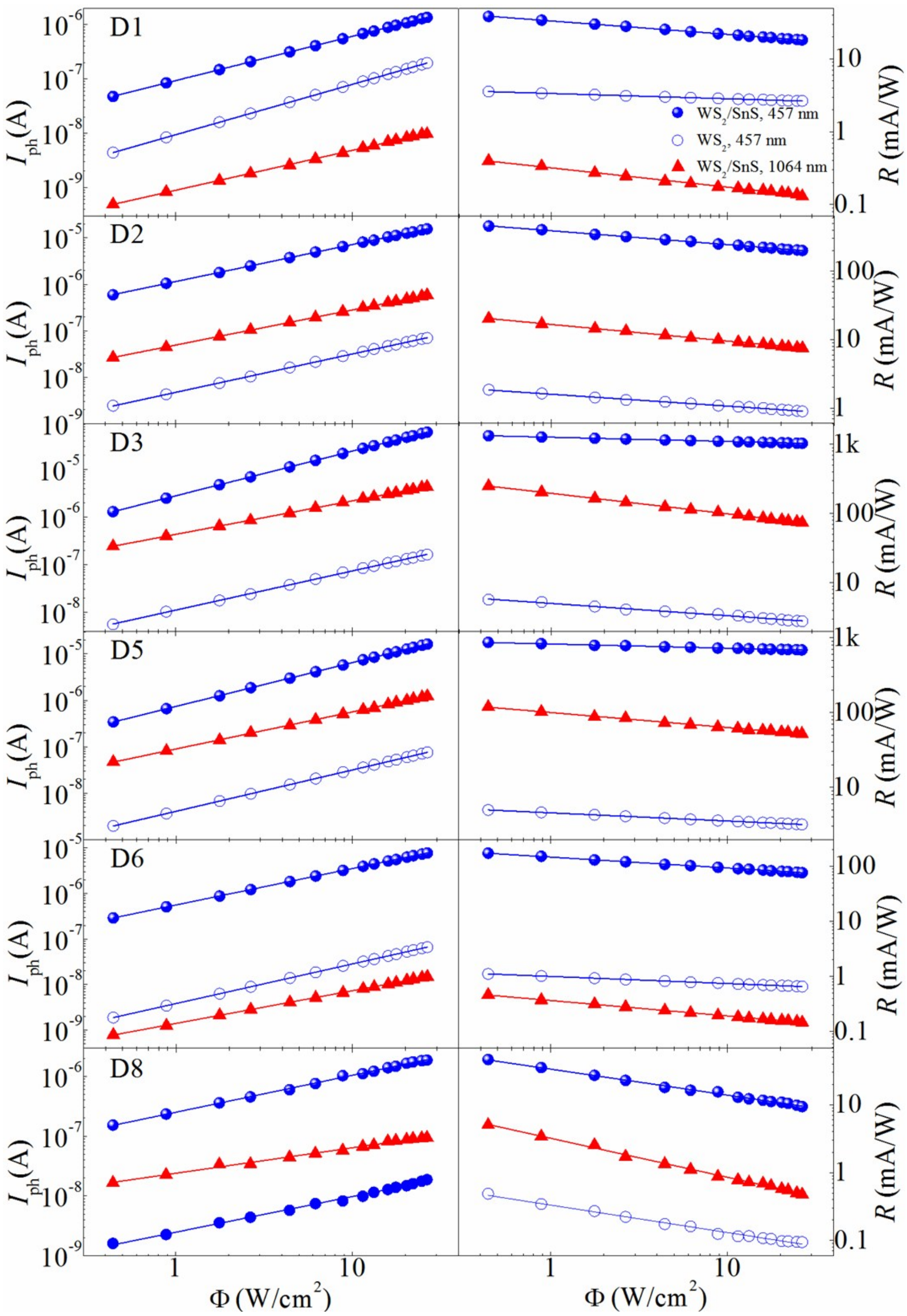

Figure S5. Dependences of photocurrent and responsivity on power density at V_{ds}=5 V and V_g=0 V for the decorated Dn and pure WS_2 devices under excitation of 457 and 1064 nm.

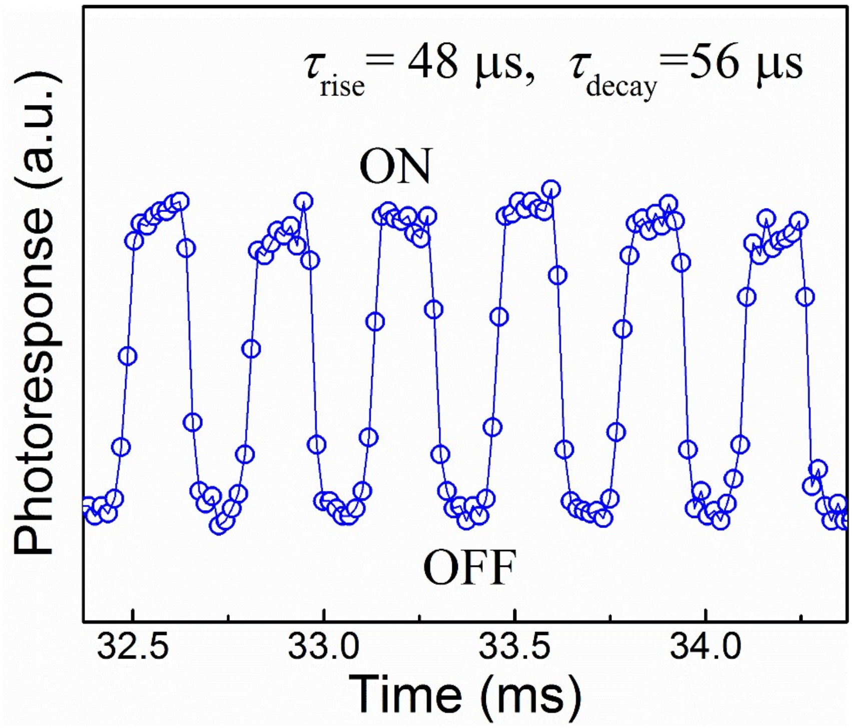

Figure S6. Temporal response of a typical pure WS_2 device (before decoration) measured at V_{ds}=5 V, V_g=0 V, and Φ=26.5 W/cm^2. The light is modulated at a frequency of 3071 Hz.

Table S1. Photocurrents and responsivities of decorated Dn phototransistors at V_g=0 V, V_{ds}=5 V, and Φ=0.44 W/cm^2.

Device	Photocurrent (A)		Responsivity (mA/W)	
	1064 nm	457 nm	1064 nm	457 nm
WS_2	--	4.41×10^{-9}	--	3.6
D1	4.92×10^{-10}	4.75×10^{-8}	0.40	38
WS_2	--	2.41×10^{-9}	--	1.9
D2	2.65×10^{-8}	5.95×10^{-7}	20	460
WS_2	--	5.60×10^{-9}	--	5.7
D3	2.44×10^{-7}	1.30×10^{-6}	250	1300
WS_2	--	2.49×10^{-9}	--	0.77
D4	3.19×10^{-7}	5.95×10^{-6}	98	1800
WS_2	--	1.97×10^{-9}	--	5.0
D5	4.72×10^{-8}	3.44×10^{-7}	120	870
WS_2	--	1.88×10^{-9}	--	1.1
D6	7.85×10^{-10}	2.91×10^{-7}	0.47	170
WS_2	--	1.12×10^{-8}	--	3.7
D7	5.50×10^{-10}	1.57×10^{-7}	0.18	51
WS_2	--	1.61×10^{-9}	--	0.49
D8	1.67×10^{-8}	1.53×10^{-7}	5.1	46

Table S2 Photodetection performance at room temperature for photodetectors based on layered materials. The gate voltage is zero unless specified for three terminal devices. L/W refers to the length and width of the conducting channel in unit of μm. QD – Quantum dot, NS – Nanosheet, NC – Nanocrystal, ML – Monolayer, FL – Fewer layer, HTS – hydrothermal synthesis, CVD – Chemical vapor deposition, MSD – Magneto sputtering deposition, PVD – Physical vapor deposition, PLD – Pulsed laser deposition, ME – Mechanical exfoliation, GRN-Graphene

Active materials	Architecture	L(μm)/W (μm)	Spectral range (nm)	Responsivity (mA/W)	Power or power intensity	Response time (Rise/Decay) (ms)	Mobility @dark ($cm^2V^{-1}s^{-1}$)	Ref.
SnS NS/ML WS_2(CVD)	3-terminal	23/20	457-1064	97.85 (1064 nm), 1.8E3 (457 nm)	440 mW/cm^2	0.052/0.098	5.82	Present work
ML WS_2(CVD)	2-terminal	50/500	Visible	≈9.2E-2	N/A	5.3/5.3	N/A	1
ML WS_2(CVD)	3-terminal	30/230	532	≈2.5 (V_g=60V)	≈0.21 mW	<4.5	0.91	2
FL WS_2 (ME)	3-terminal	15/20	Red/White	5.7E3	30 mW/cm^2	<20	12	3
ML MoS_2 (ME)	3-terminal	2.1/2.6	Visible	7.5(V_g=50V)	80 μW	50/50	0.11	4
SnS/SnS_2 (PVD)	3-terminal	≈8/8 (SnS)	405	27.08	3.2 μW	N/A	10.6 (SnS)	5
SnS nanobelts (PVD)	2-terminal	≈4/0.8	800	3E5	2.57 mW/cm^2	36/7	N/A	6
SnSe NS thin film (HTS)	3-terminal	10/200	Visible	≈26.4	0.32 mW/cm^2	190/190	N/A	7
SnSe NC/ML WS_2 (CVD)	3-terminal	6.6/8.8	457-1064	99	440 mW/cm^2	8.2/8.4	2.2	8
GRN QDs/FL MoS_2 (CVD)	3-terminal	≈240/240	405	≈1E4	50 nW	70/1.23E3	N/A	9
R6G/ML MoS_2 (ME)	3-terminal	6.25/13	405-980	1.17E3	1 μW	5.1E-3/2.3E3	N/A	10
PbS QDs/FL MoS_2 (ME)	3-terminal	≈4/3	400-1500	≈2E8(V_g= -60)	13 $\mu W/cm^2$	30-40	<20	11
PbS QDs/GRN (ME)	3-terminal	≈10/1	600-1600	≈5E10	<10 fW	~10/~100	N/A	12
PbSe QDs/FL MoS_2	2-terminal	5/20000	1200	≈1.9E-3	N/A	250/430	N/A	13
PbS QDs/InGaZnO (MSD)	3-terminal	50/1000	700-1400	≈1.7E8(V_g=20V)	1.28 $\mu W/cm^2$	9.6E-5/9.6E-5	≈12.61	14
Pbs QDs-GRN(CVD)	3-terminal	100/2000	895	≈1E5	32.7 mW/cm^2	300/1.7E4	~440(e) ~1000 (h)	15
GRN/ML MoS_2(CVD)	3-terminal	≈100/300	650	≈4E6(V_g=30V)	10 mW/cm^2	N/A	N/A	16
GaSe NS/GRN	3-terminal	5/20	532	≈2.2E5	200 mW/cm^2	10/12.8	N/A	17
GRN/MoS_2(ME)	3-terminal	≈40/8	635	≈6E10(V_g=-60V)	350 $fW/\mu m^2$	≈1000	≈1E4	18
PbS QDs/GRN(CVD)	3-terminal	100/100	white	≈220	6.8 mW/cm2	>1×10^4	>1E3	19
Bi_2Te_3 NS/GRN	2-terminal	N/A	532	≈1.4E3	115 μW	20/20	N/A	20
WS_2 thin film (PLD)	3-terminal	~100/1500	370-1064	510	10 mW/cm^2	4.1E3/4.4E3	31	21
α-In_2Te_3 thin film	3-terminal	15/2000	370-1064	4.4E4	7$\mu W/cm^2$	15/15	N/A	22
Bi/WS_2/Si film	3-terminal	N/A	370-1064	400	10 mW/cm^2	N/A	N/A	23
Bi_2Te_3/WS_2 film	3-terminal	40/2500	370-1550	3.07E4	20 $\mu W/cm^2$	20/20	N/A	24
GRN/MoS_2/GRN (ME)	3-terminal	≈4/8	488	220	80 μW	N/A	N/A	25
Perovskite/ML WS_2(CVD)	2-terminal	≈10/2000	white	≈330	7 mW/cm^2	2.7/7.5	N/A	26

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