Supporting information for

Facile Fabrication and Characterizations of Two-Dimensional Bismuth (III) Sulfide Nanosheets for High-Performance Photodetector Applications under Ambient Conditions

Weichun Huang,‡[a] Chenyang Xing,‡[a] Yunzheng Wang,[a] Zhongjun Li,[b] Leiming Wu,[b] Dingtao Ma,[b] Xiaoyu Dai,[a] Yuanjiang Xiang,[a] Jianqing Li,[b] Dianyuan Fan,[a] and Han Zhang*[a]

[a.] SZU-NUS Collaborative Innovation Centre for Optoelectronic Science & Technology, and Key Laboratory of Optoelectronic Devices and Systems of Ministry of Education and Guangdong Province, College of Optoelectronic Engineering, Shenzhen University, Shenzhen 518060, China. E-mail: hzhang@szu.edu.cn

[b.] Faculty of Information Technology, Macau University of Science and Technology, Macao 519020, P. R. China

‡*Denotes equal first-author contribution.*

Table S1 The light powder density (P_λ) of incident light with various irradiation wavelengths.

The gradually increased P_λ were labelled with **I**, **II**, **III**, **IV**, and **VI** levels, respectively.

P_λ (mW/cm^2)	**I** level	**II** level	**III** level	**IV** level	**VI** level
Simulated light (SL)	26.2	53.0	83.1	118	122
365 nm	0.764	1.66	2.55	3.57	3.69
400 nm	0.637	2.04	3.57	5.22	5.35
475 nm	1.91	4.33	7.01	10.1	10.6
550 nm	2.04	3.95	5.98	8.28	8.40
650 nm	2.04	4.08	6.02	8.54	8.92
700 nm	1.15	2.42	4.08	6.11	6.14

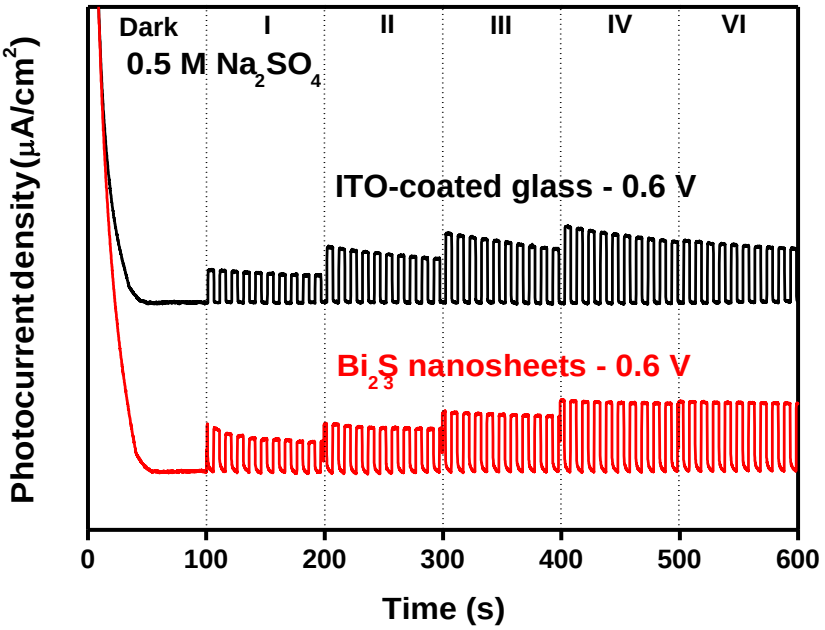

Fig. S1. Photoresponse behaviours of the Bi_2S_3 nanosheets-based photodetector illuminated by SL in 0.5 M Na_2SO_4 at a bias potential of 0.6 V. The ON/OFF time internal is 5s.

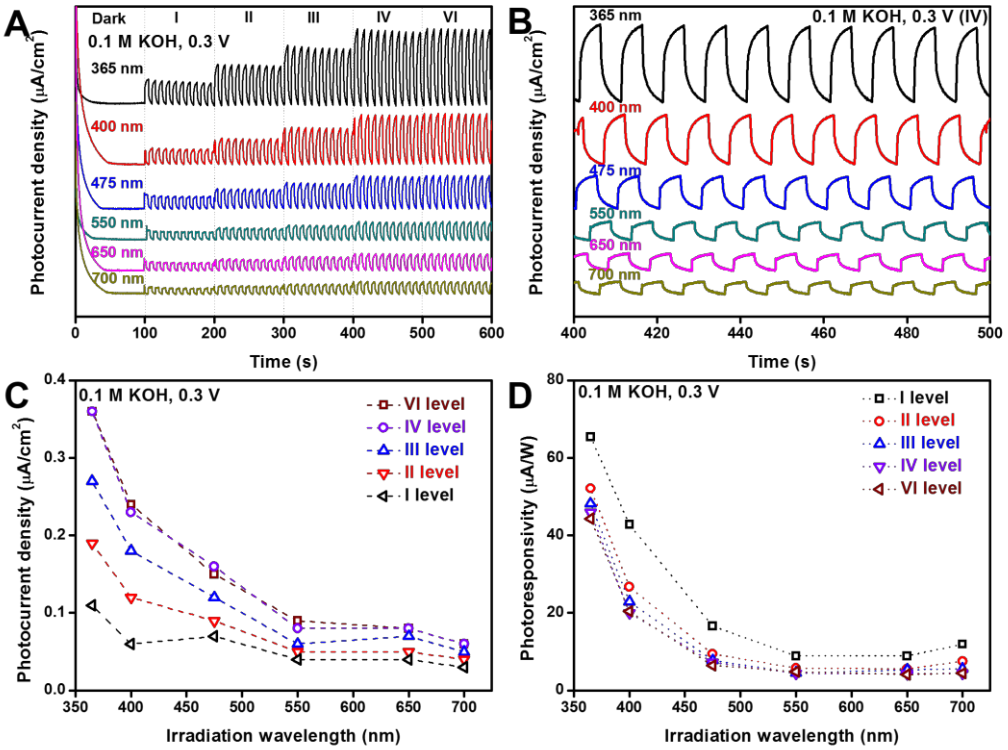

Fig. S2. Photoresponse behaviour of the Bi_2S_3 nanosheets-based photodetector under the illuminations of light (365, 400, 475, 550, 650, and 700 nm), at an applied bias potential of 0.3 V in 0.1 M KOH, under various light power densities of **I**, **II**, **III**, **IV** and **VI** levels. For clarity, a naked ITO-coated glass was added in the profiles. (A) ON/OFF switching behaviours of photocurrent density (I_{ph}) as a function of time, and (B) selected region under light power density at **IV** level. The ON/OFF time internal is 5s. (C) I_{ph} values as a function of irradiation wavelength under various light power densities. (D) Photoresponsivity (R_{ph}) values as a function of irradiation wavelength under various light power densities.

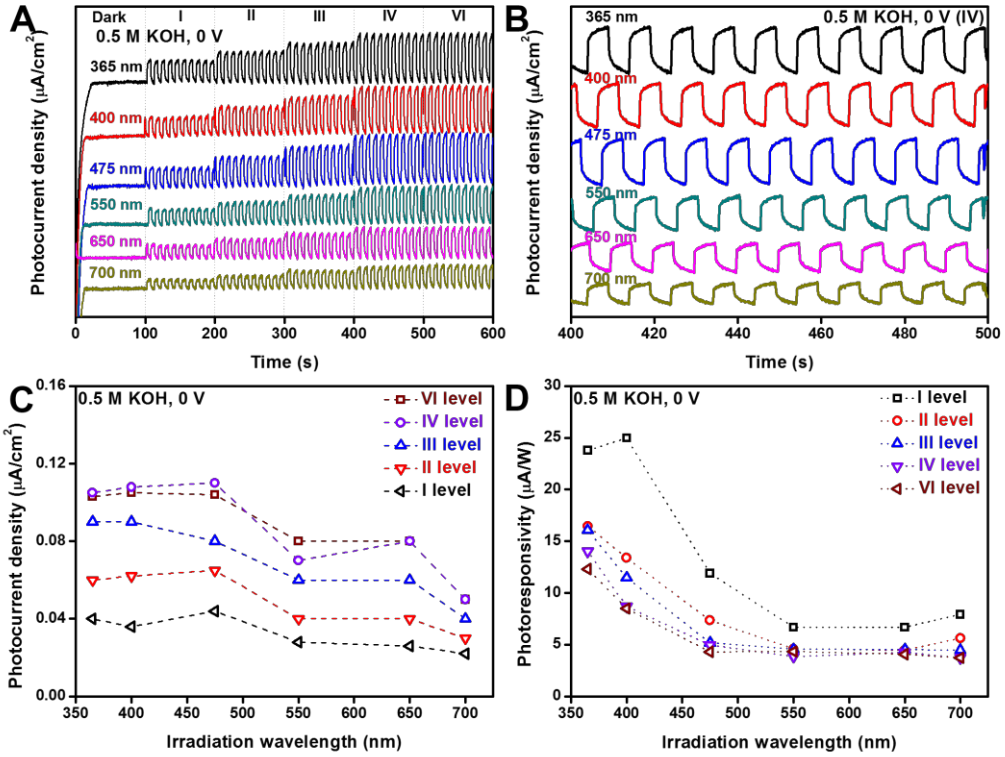

Fig. S3. Photoresponse behaviour of the Bi_2S_3 nanosheets-based photodetector under the illuminations of light (365, 400, 475, 550, 650, and 700 nm), at an applied bias potential of 0.6 V in 0.5 M KOH, under various light power densities of **I**, **II**, **III**, **IV** and **VI** levels. For clarity, a naked ITO-coated glass was added in the profiles. (A) ON/OFF switching behaviours of photocurrent density (I_{ph}) as a function of time, and (B) selected region under light power density at **IV** level. The ON/OFF time internal is 5s. (C) I_{ph} values as a function of irradiation wavelength under various light power densities. (D) Photoresponsivity (R_{ph}) values as a function of irradiation wavelength under various light power densities.

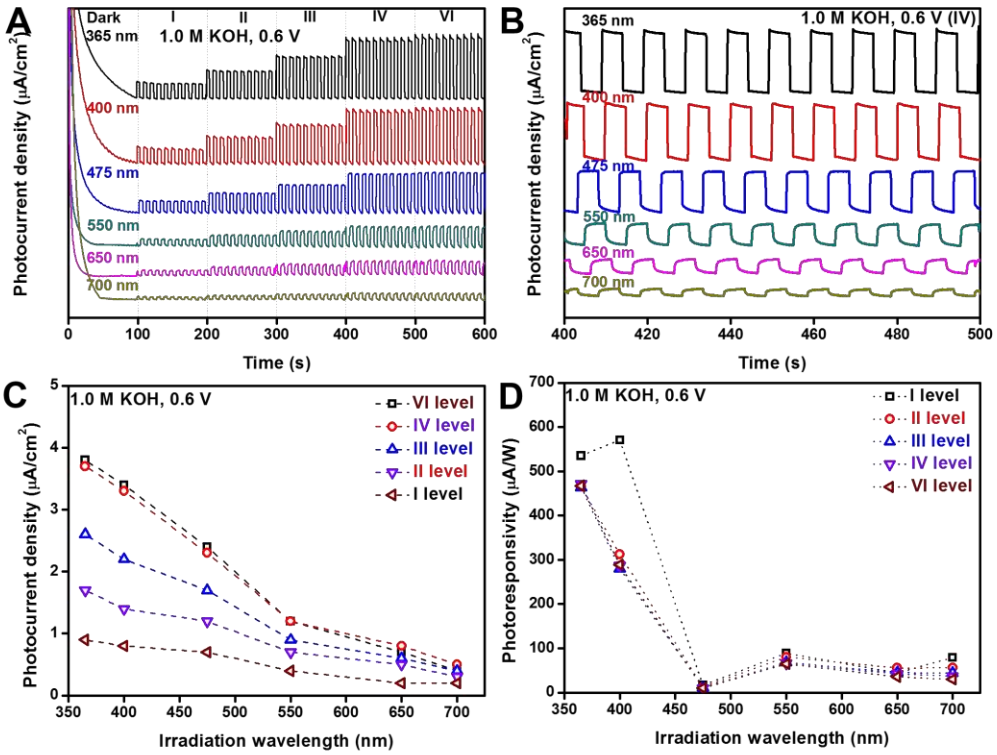

Fig. S4. Photoresponse behaviour of the Bi_2S_3 nanosheets-based photodetector under the illuminations of light (365, 400, 475, 550, 650, and 700 nm), at an applied bias potential of 0.6 V in 1.0 M KOH, under various light power densities of **I**, **II**, **III**, **IV** and **VI** levels. For clarity, a naked ITO-coated glass was added in the profiles. (A) ON/OFF switching behaviours of photocurrent density (I_{ph}) as a function of time, and (B) selected region under light power density at **IV** level. The ON/OFF time internal is 5s. (C) I_{ph} values as a function of irradiation wavelength under various light power densities. (D) Photoresponsivity (R_{ph}) values as a function of irradiation wavelength under various light power densities.

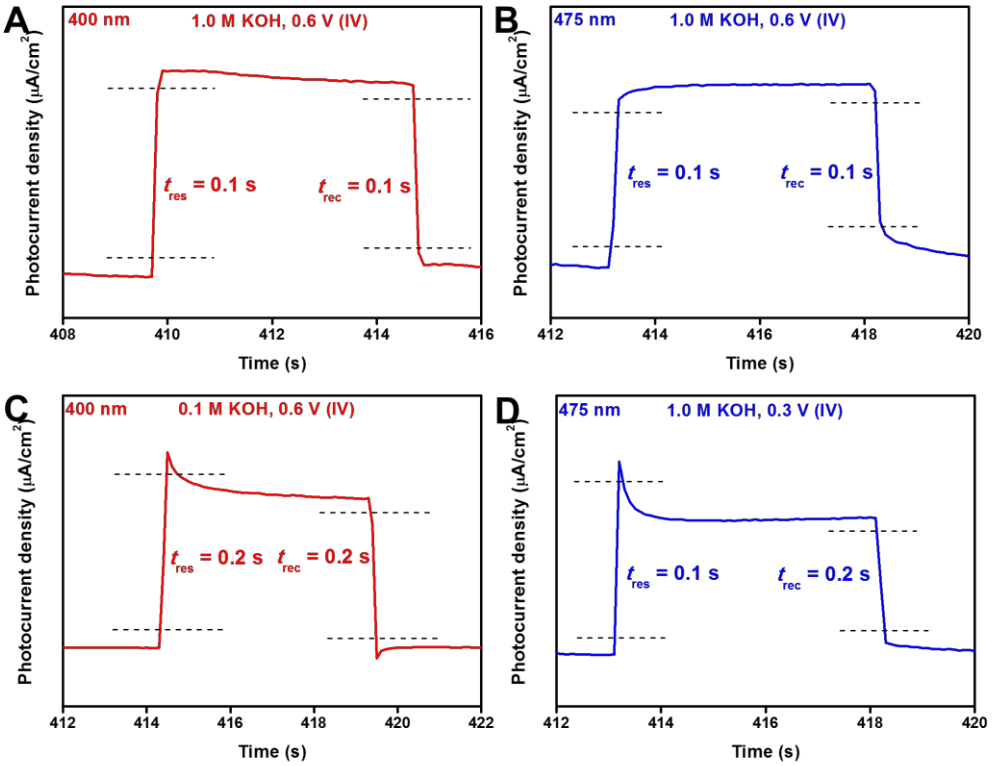

Fig. S5. The profiles of response time (t_{res}) and recovery time (t_{rec}) of the Bi_2S_3nanosheets-based photodetector in various KOH concentration and applied bias potentials at 400 nm and 475 nm at the same level **IV**. (A) 400 nm, 1.0 M KOH, 0.6 V; (B) 475 nm, 1.0 M KOH, 0.6 V; (C) 400 nm, 0.1 M KOH, 0.6 V; (D) 475 nm, 1.0 M KOH, 0.3 V.

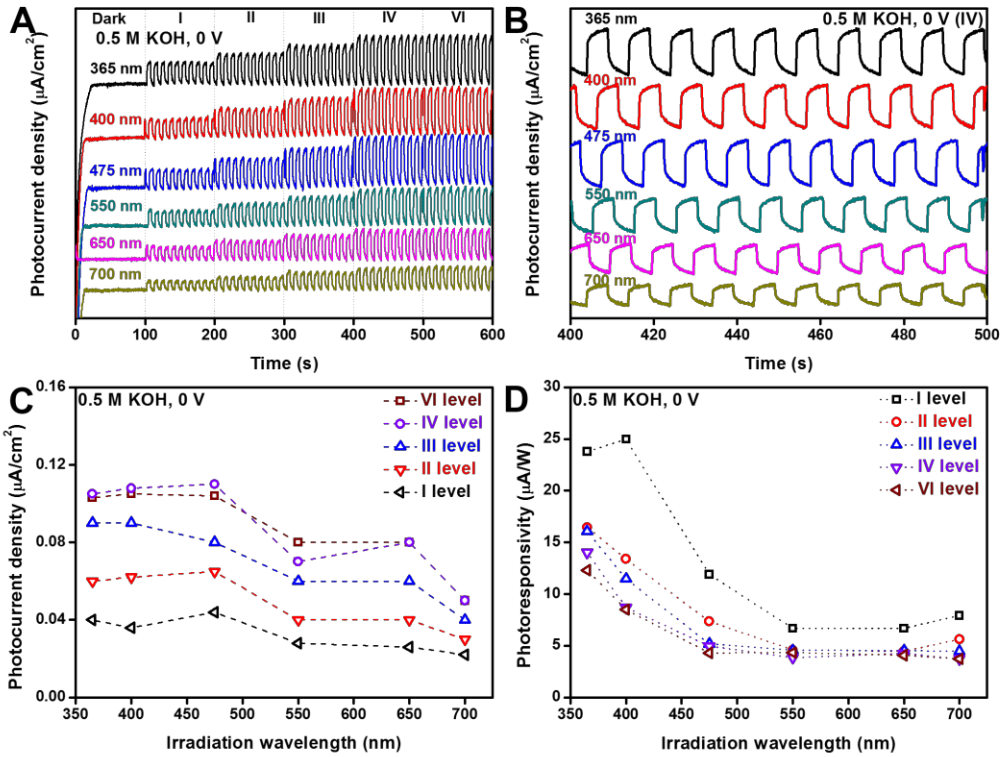

Fig. S6. Self-driven photoresponse behaviour of the Bi_2S_3 nanosheets-based photodetector under the illuminations of light (365, 400, 475, 550, 650, and 700 nm), without an applied bias potential (0 V) in 0.5 M KOH under various light power densities of **I**, **II**, **III**, **IV** and **VI** levels. For clarity, a naked ITO-coated glass was added in the profiles. (A) ON/OFF switching behaviours of photocurrent density (I_{ph}) as a function of time, and (B) selected region under light power density at **IV** level. The ON/OFF time internal is 5s. (C) I_{ph} values as a function of irradiation wavelength under various light power densities. (D) Photoresponsivity (R_{ph}) values as a function of irradiation wavelength under various light power densities.

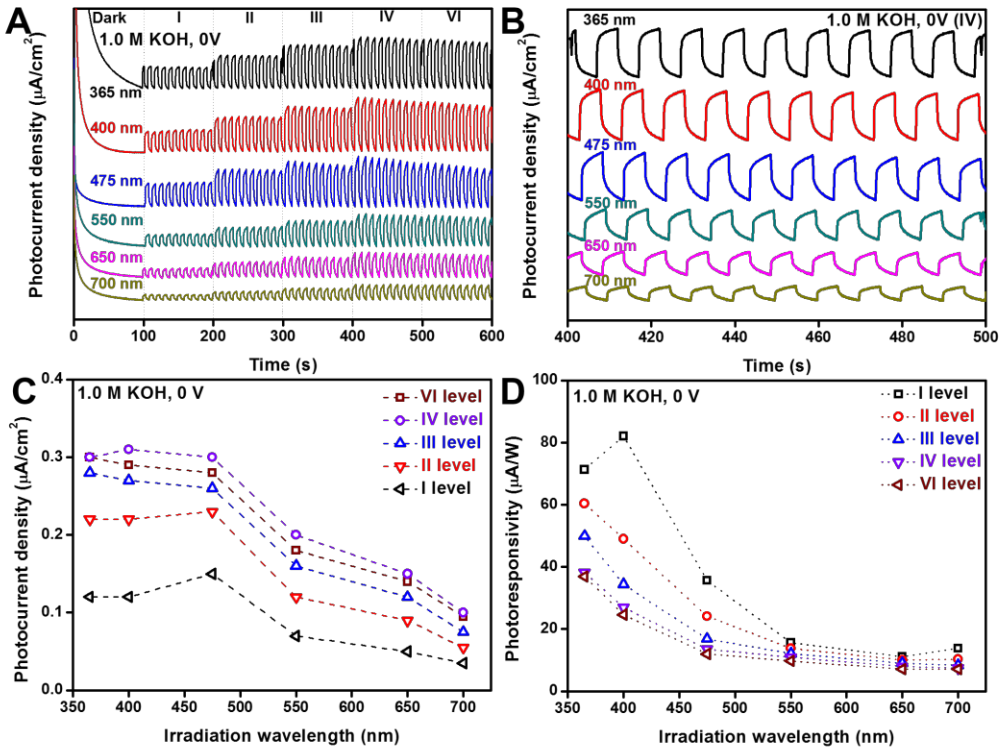

Fig. S7. Self-driven photoresponse behaviour of the Bi_2S_3 nanosheets-based photodetector under the illuminations of light (365, 400, 475, 550, 650, and 700 nm), without an applied bias potential (0 V) in 1.0 M KOH under various light power densities of **I**, **II**, **III**, **IV** and **VI** levels. For clarity, a naked ITO-coated glass was added in the profiles. (A) ON/OFF switching behaviours of photocurrent density (I_{ph}) as a function of time, and (B) selected region under light power density at **IV** level. The ON/OFF time internal is 5s. (C) I_{ph} values as a function of irradiation wavelength under various light power densities. (D) Photoresponsivity (R_{ph}) values as a function of irradiation wavelength under various light power densities.

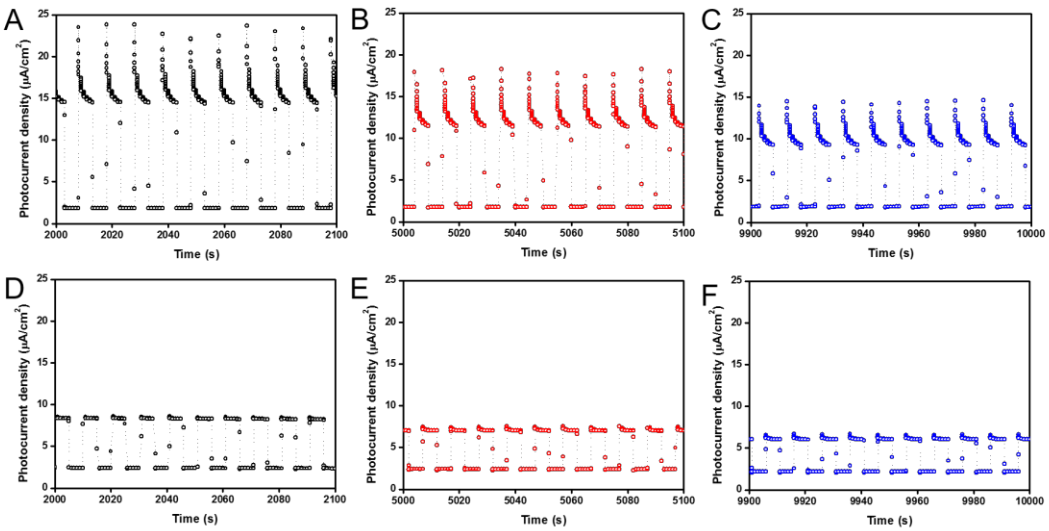

Fig. S8. Stability of photoresponse behaviour of the Bi_2S_3 nanosheets-based photodetector illuminated by SL in 0.1 M KOH at a bias potential of 0.6 V before (A, B and C) and after (D, E and F) 1 month at **IV** level. A typical stability measurement lasted 10,000 s and specific moments of 2,000 s to 2,100 s (A and D), 5,000 s to 5,100 s (B and E) and 9,900 s to 10,000 s (C and F) were chosen to evaluate their stability behaviours.