Electronic Supplementary Information

A high-performance broadband double-junction photodetector based on silicon nanowire arrays wrapped by silver nanoparticles for low-light imaging

Yuting Huang,[a] Haifeng Liang,*[b] Yingli Zhang,[a] Shujing Yin,[a] Xuyang Li,[a] Changlong Cai,[a] Weiguo Liu[a] and Tiantian Jia[c]

[a] Key laboratory for optical measurement and thin films of Shaanxi Province, Xi'an Technological University, Xi'an, Shaanxi 710021, China

[b] College of integrated circuits and optoelectronic chips, Shenzhen Technology University, Shenzhen, Guangdong 518118, China

[c] Key Laboratory of Low-Light-Level Night Vision Technology, Xi'an, Shaanxi 710065, China

*Corresponding author: E-mail: lianghaifeng@xatu.edu.cn

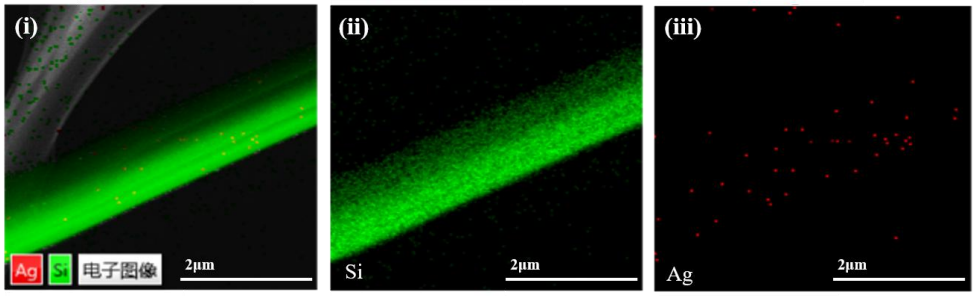

Fig. S1 Energy spectrum mapping of (i) silicon and silver elements of layer image, (ii) silicon and (iii) silver elements.

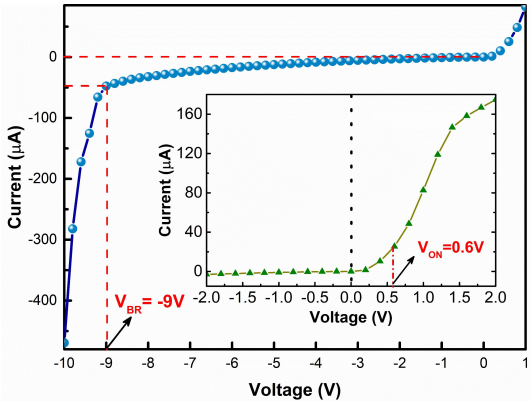

Fig. S2 *I-V* characteristic curve of the device measured in 650 nm irradiation, the breakdown voltage was approximately -9 V, and the inset shows the turn-on voltage was 0.6 V.

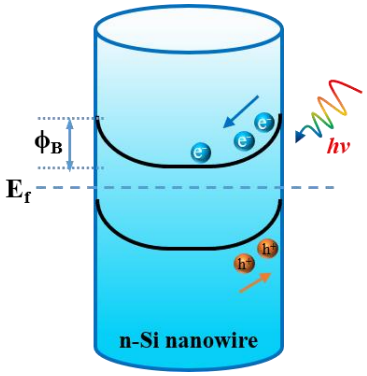

Fig. S3 Nanowire surface band bending and photogenerated carriers are separated under illumination, $\varphi_B$the recombination barrier.

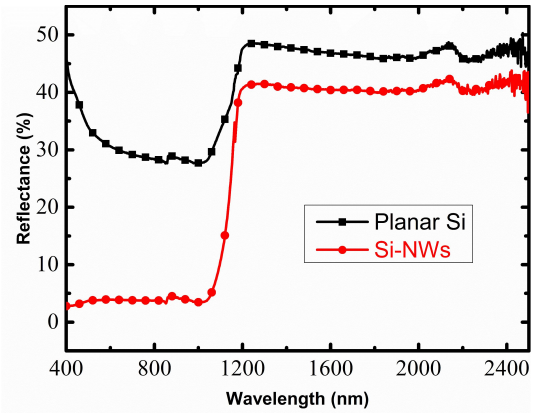

Fig. S4 UV-vis-NIR reflectance spectra of the SiNW arrays and planar Si.

Table S1. Comparison of the typical figure of merits between our NN^+/MS double junction enhanced SiNWs@AgNPs photodetector and other reported the nanowire silicon-based devices, mainly including *R*, Response wavelength range, *D**, I_{dark}, response speed (rise/fall time), and weak light sensitivity (low light intensity that can be detected).

Category	Devices	*R* [A/W]	Photo-response range [μm]	*D** [cm $Hz^{1/2}$/W]	I_{dark} [A]	Rise/fall time [μs]	Low power intensity	Ref.
Junction structure	p-SiNWs/nCdS nanoparticles	0.821 @900 nm	0.2-1.1	1.21×10^{12}	~2×10^{-7}	203 ms/ 429 ms	8 μW/cm^2 ~ 1 mW/cm^2	1
	$PdSe_2$/SiNWA	0.726 @980 nm	0.2–2	3.19×10^{14}	~10^{-10}	3.4/3.9	27.5~56.6 nW/cm^2	2
	MoS_2/Al_2O_3/SiNWs	0.61 @808 nm	0.3-1.6	1.48×10^{12}	~10^{-9}	8.4/40.9	1.4 nW/cm^2 ~ 714.3 mW/cm^2	3
	perovskite nanowires/Au	37.14 @473 nm	0.35-0.9	2.06×10^{13}	~10^{-10}	91/563	1.45 nW/cm^2~ 145 mW/cm^2	4
plasmonic enhanced detector	AgNP/SiOx NW/Si	1.54 @370nm	0.3-0.85	2.12×10^{10}	~10^{-10}	0.12s/ 0.11s	/	5
	rGO:AuCQD/Si NW	0.5 @940nm	0.36-0.94	1.4×10^{12}	~10^{-10}	750ms/ 667ms	0.2 μW/cm^2 ~ 0.6 mW/cm^2	6
	MoS_2/AgNPs/Si NWs	402.4 @532nm	0.405-0.635	2.34×10^{12}	~10^{-4}	41ms/ 37ms	0.13 ~ 231.7 mW/cm^2	7
	Au antennas/All-Si	0.05 @980nm	0.8-1.6	2×10^{11}	/	/	/	8
	Perovskite/Au squares/Si/SiO	4.2 @800nm	0.6-0.9	7.1×10^{11}	~10^{-9}	/	1 mW/cm^2	9
	rGO/CQD/AgNP /Si	0.3 @940nm	0.36-0.94	4.1×10^{11}	~10^{-9}	556 ms/ 526 ms	1 μW/cm^2 ~ 1 mW/cm^2	10
NN^+/MS double junction structure and plasmonic enhanced	SiNWs/AgNPs	2.2 @980nm	0.254-2.2	5.1×10^{14}	~2×10^{-12}	25/62	1.4nW/cm^2~ 64.3mW/cm^2	This work

R, *D**, and I_{dark} represent responsivity, specific detectivity, and dark current, respectively. rGO and CQD represent reduced graphene oxide, quantum dot.

Supplementary References

1 A. Chandra, S. Giri, B. Das, S. Ghosh, S. Sarkar and K. K. Chattopadhyay, *Appl. Surf. Sci.*, 2021, **548**, 149256.

2 D. Wu, C. Jia, F. Shi, L. Zeng, P. Lin, L. Dong, Z. Shi, Y. Tian, X. Li and J. Jie, *J. Mater. Chem. A*, 2020, **8**, 3632-3642.

3 J. Mao, B. Zhang, Y. Shi, X. Wu, Y. He, D. Wu, J. Jie, C.-S. Lee and X. Zhang, *Adv. Funct. Mater.*, 2022, **32**, 2108174.

4 D. Wu, Y. Xu, H. Zhou, X. Feng, J. Zhang, X. Pan, Z. Gao, R. Wang, G. Ma, L. Tao, H. Wang, J. Duan, H. Wan, J. Zhang, L. Shen, H. Wang and T. Zhai, *InfoMat.*, 2022, **4**, e12320.

5 N. M. Devi, S. A. Lynrah, R. Rajkumari and N. K. Singh, *Sens. Actuators A: Phys.*, 2021, **327**, 112744.

6 K. Sarkar, P. Devi, A. Lata, V. K. Lokku and P. Kumar, *Adv. Opt. Mater.*, 2020, **8**, 2000228.

7 C.-H. Mao, A. Dubey, F.-J. Lee, C.-Y. Chen, S.-Y. Tang, A. Ranjan, M.-Y. Lu, Y.-L. Chueh, S. Gwo and T.-J. Yen, *ACS Appl. Mater. Interfaces*, 2021, **13**, 4126-4132.

8 B. Feng, J. Zhu, B. LU, F. Liu, L. Zhou and Y. Chen, *ACS Nano*, 2019, **13**, 8433-8441.

9 B. Du, W. Yang, Q. Jiang, H. Shan, D. Luo, B. Li, W. Tang, F. Lin, B. Shen, Q. Gong, X. Zhu, R. Zhu and Z. Fang, *Adv. Optical Mater.*, 2018, **6**, 1701271.

10 K. Sarkar, P. Devi, A. Lata, R. Ghosha and P. Kumar, *J. Mater. Chem. C*, 2019, **7**, 13182.