Supplementary Information (SI)

A Self-Powered Bi-Directional SnS_2/SnSe Heterostructure for an All-in-One Optoelectronic Logic Device

Preeti Goswami[1,2], Pukhraj Prajapat[1,2], Pargam Vashishtha[3], Preetam Singh[1,2], Govind Gupta[1,2*]

[1]Academy of Scientific and Innovative Research, Ghaziabad, Uttar Pradesh 201002, India.

[2]CSIR-National Physical Laboratory, Dr. K.S. Krishnan Road, New Delhi 110012, India.

[3]Department of Electrical Engineering and Computer Science, University of Arkansas, Fayetteville, Arkansas-72701, USA.

[*]Corresponding Author's email address: govindnpl@gmail.com

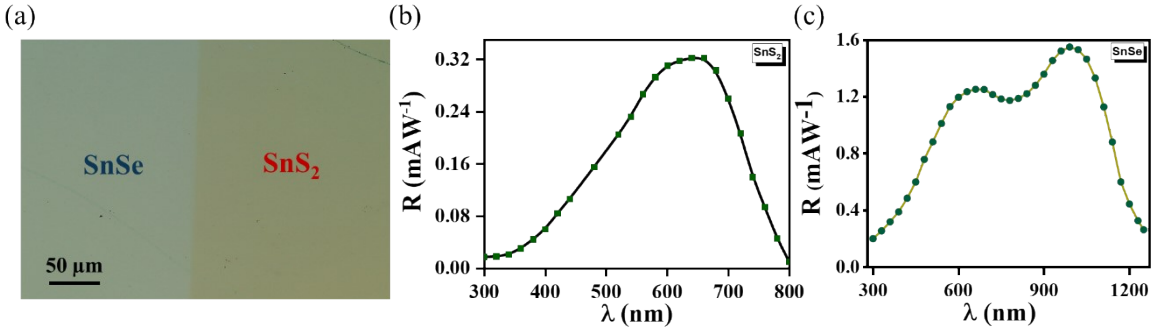

Figure S1: (a) Optical image of the SnS_2/SnSe heterostructure. Spectral responsivity for (b) SnS_2 (c) SnSe, respectively.

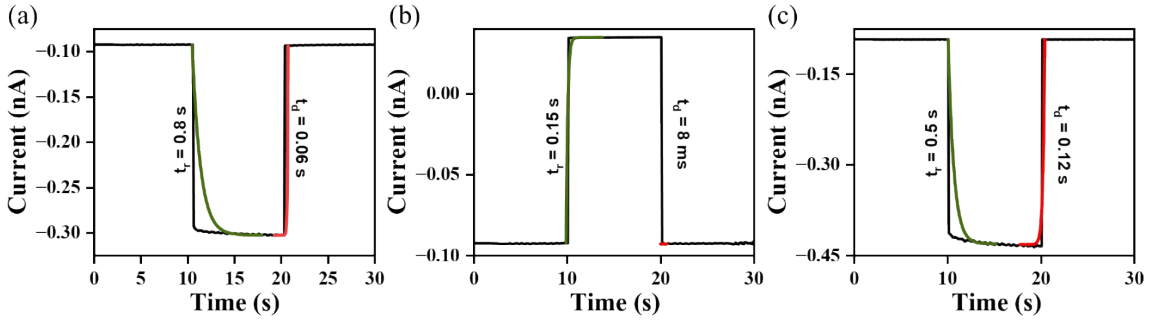

Figure S2: Response time calculated by exponential fitting for (a) 355 nm, (b) 626 nm, and (c) 1064 nm.

The following exponential equations are employed for response time evaluation.

$$I = I_0 (1 - \exp(-t/t_r)) \quad (1)$$

$$I = I_0 \exp(-t/t_d) \quad (2)$$

I_0, t_r, and t_d present the maximum light current, rise time, and decay time.

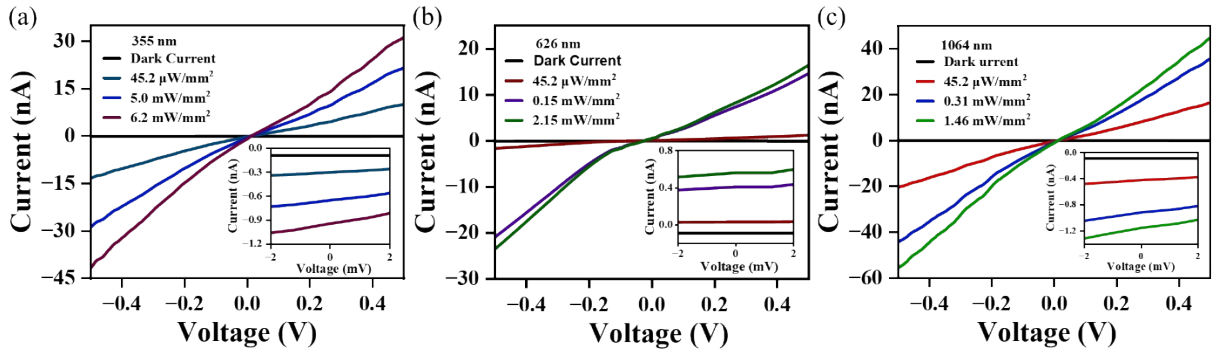

Figure S3: Power-dependent I–V measurements of the SnS_2//SnSe vertical heterojunction-based device for (a) 355 nm, (b) 626 nm, and (c) 1064 nm lasers, respectively. The non-zero current at 0V in the insets marks the sustainability of the self-powered and polarity-flipping character of the device with power variations.

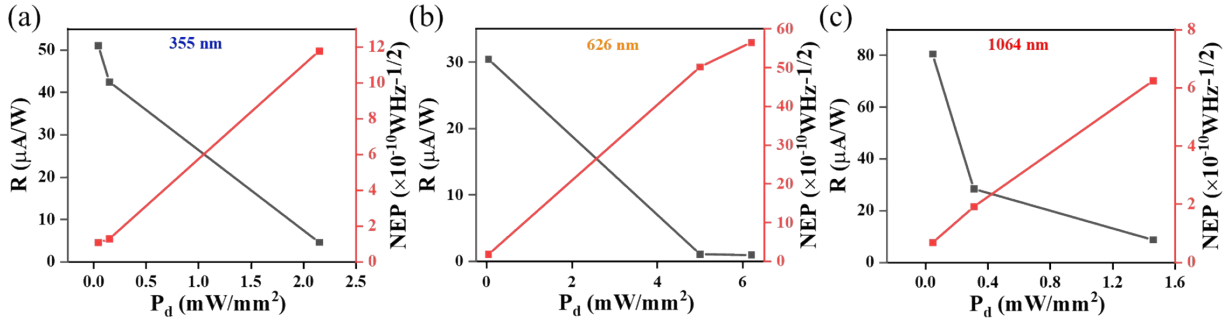

Figure S4: Responsivity and Noise equivalent power curves with power variations for lasers (a) 355 nm, (b) 626 nm, (c) and 1064 nm, respectively.

The figure of merit parameters like responsivity and noise equivalent power for the developed heterostructure-based PD are calculated by the following relation.

$$R = I_{ph}/P_d\ A \quad (3)$$

$$NEP = (2eI_d)^{1/2}/R \quad (4)$$

Where I_{ph} presents the photocurrent, A is the device's active area, e is the electronic charge, and I_d stands for dark current, respectively.[1],[2]

References:

[1] P. Vashishtha, I. H. Abidi, S. P. Giridhar, A. K. Verma, P. Prajapat, A. Bhoriya, B. J. Murdoch, J. O. Tollerud, C. Xu, J. A. Davis, G. Gupta, S. Walia, *ACS Appl. Mater. Interfaces* **2024**, *16*, 2024.

[2] L. Goswami, N. Aggarwal, R. Verma, S. Bishnoi, S. Husale, R. Pandey, G. Gupta, *ACS Appl. Mater. Interfaces* **2020**, *12*, 47038.