Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Enhancing the photo-response performance of SnSe-based photoelectrochemical photodetector via Ga doping

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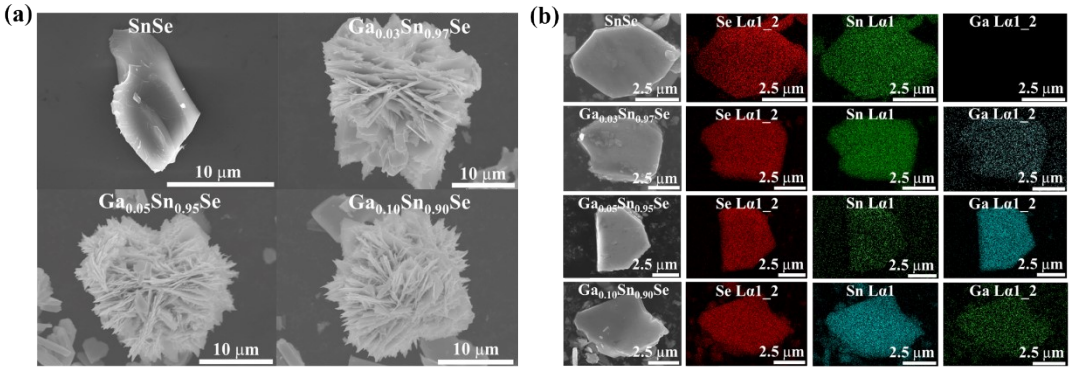

Fig. S1 (a) FESEM images and (b) EDS mapping of SnSe and $Ga_xSn_{1-x}Se$.

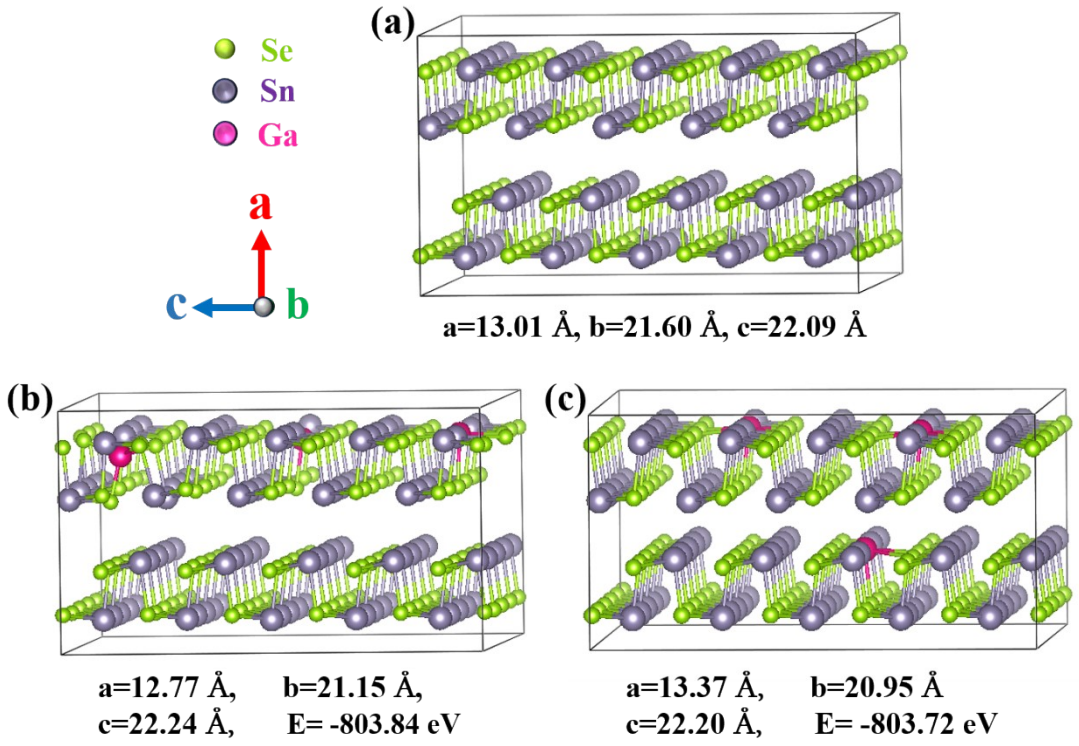

Fig. S2 Crystal structures of (a) SnSe and (b-c) $Ga_{0.03}Sn_{0.97}Se$.

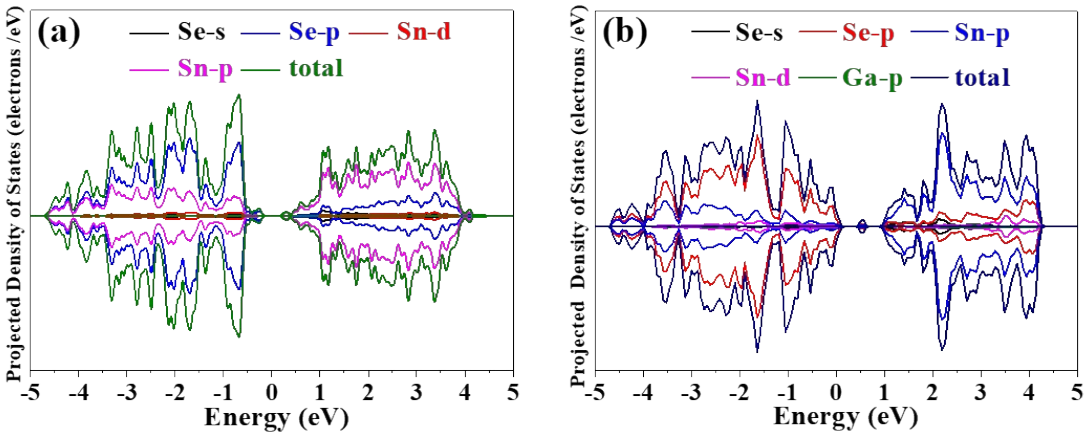

Fig. S3 Projected density of states for (a) SnSe and (b) $Ga_{0.03}Sn_{0.97}Se$.

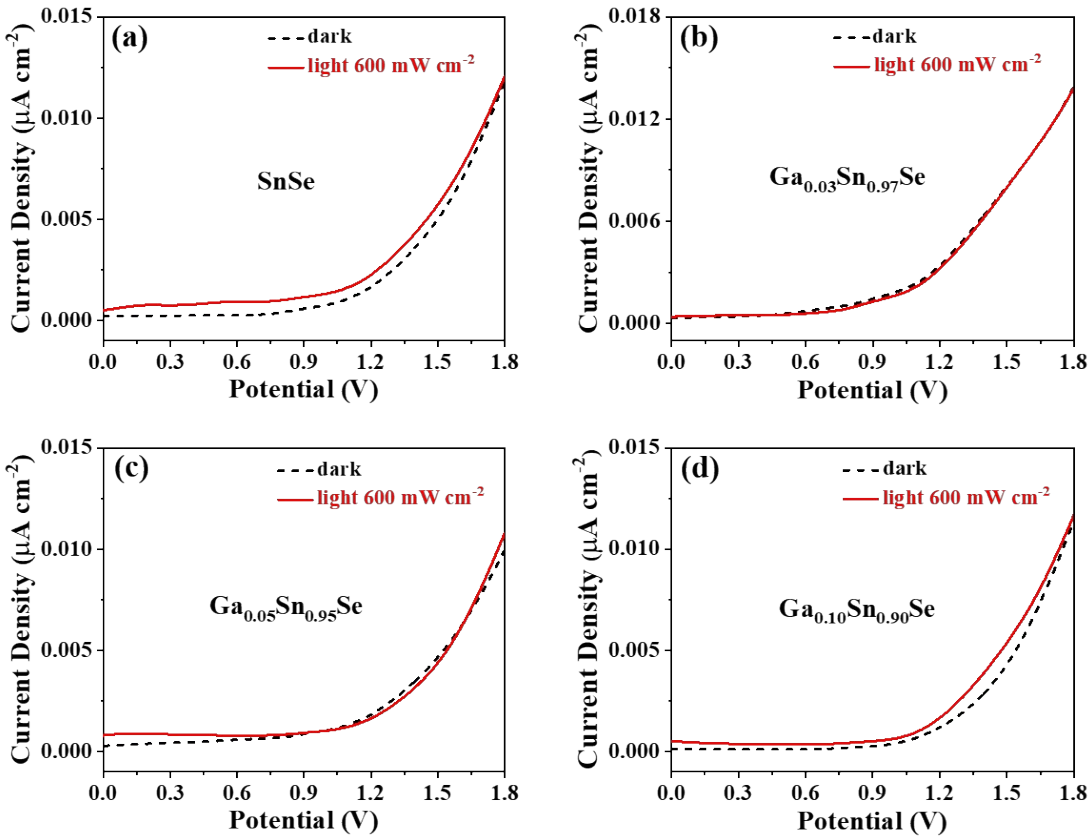

Fig. S4 The linear sweep voltammogram (LSV) curves of SnSe/$Ga_xSn_{1-x}Se$-based PEC photodetectors with and without the illumination of white light (600 mW cm^{-2}).

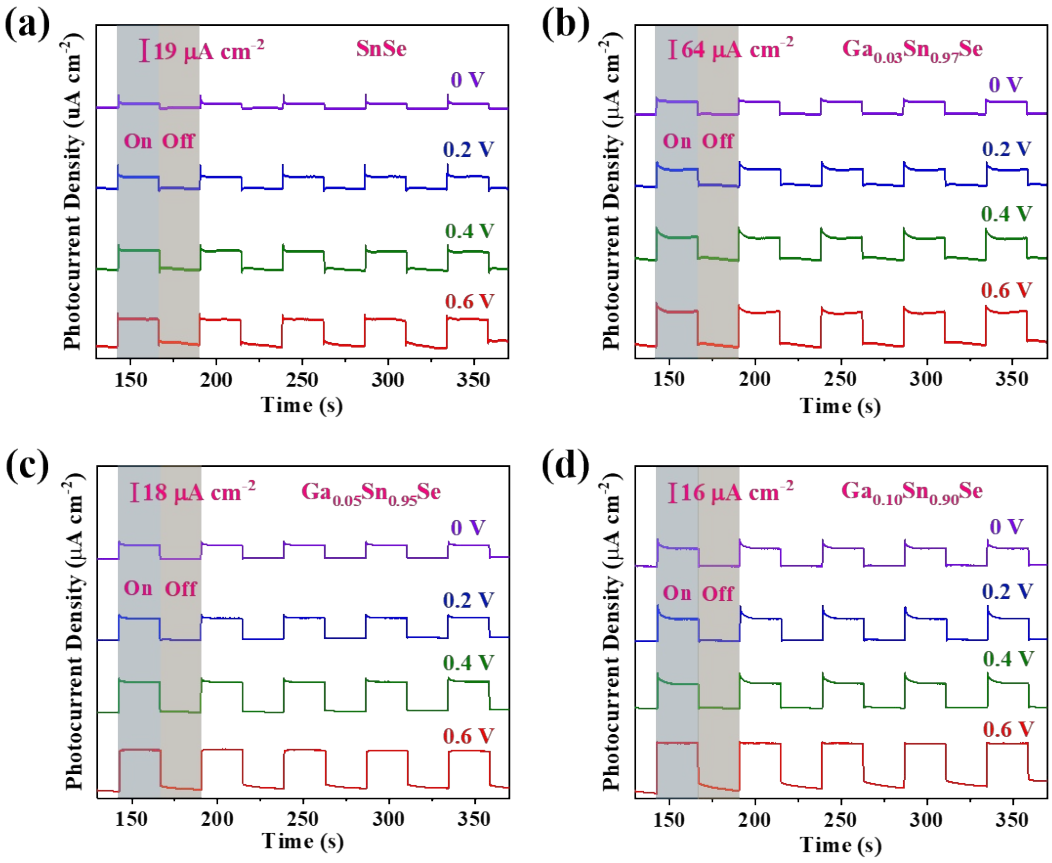

Fig. S5 I-t curves of $SnSe/Ga_xSn_{1-x}Se$-based PEC photodetectors under the illumination of white light (600 mW cm^{-2}) with various bias voltages.

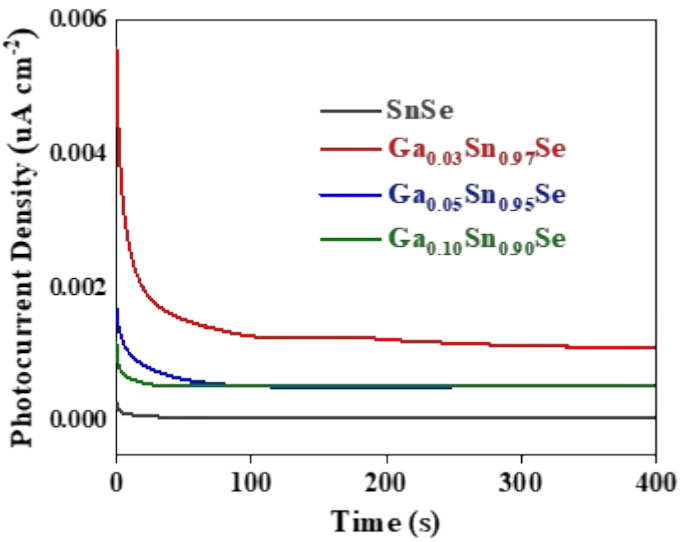

Fig S6. I-T curves of $SnSe/Ga_xSn_{1-x}Se$-based PEC photodetectors under dark conditions.

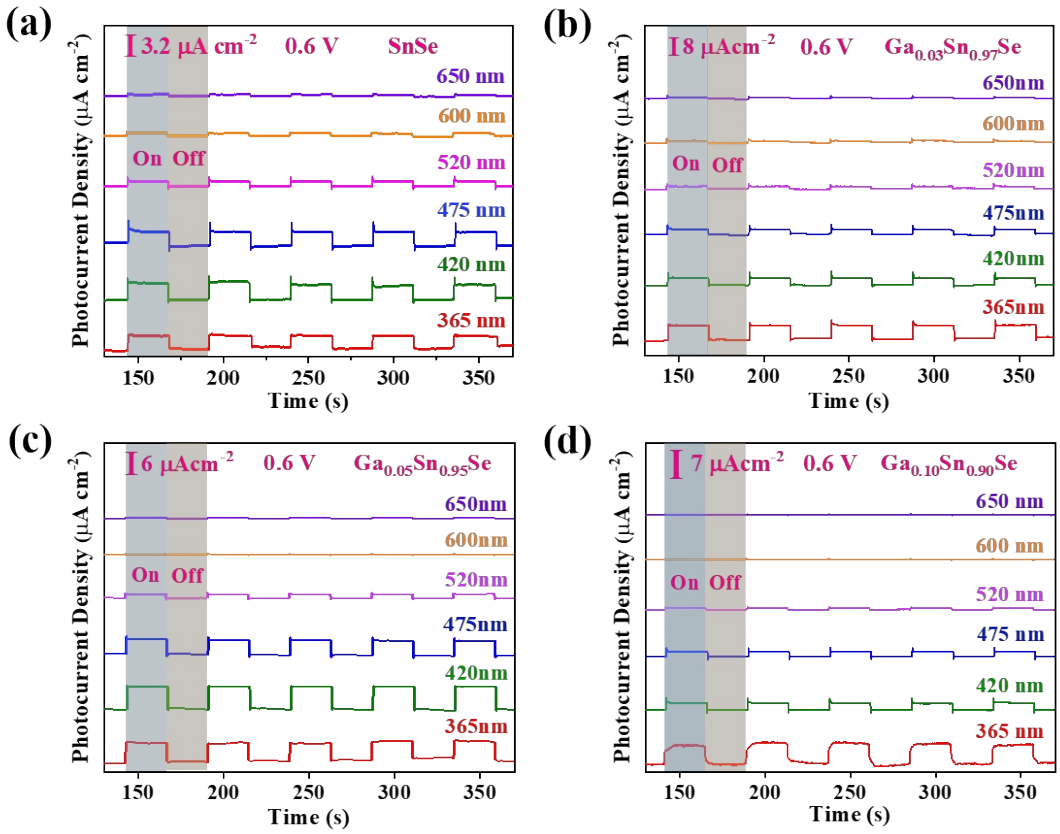

Fig. S7 I-t curves of SnSe/$Ga_xSn_{1-x}Se$-based PEC photodetectors under the illumination of different quasi-monochromatic lights.

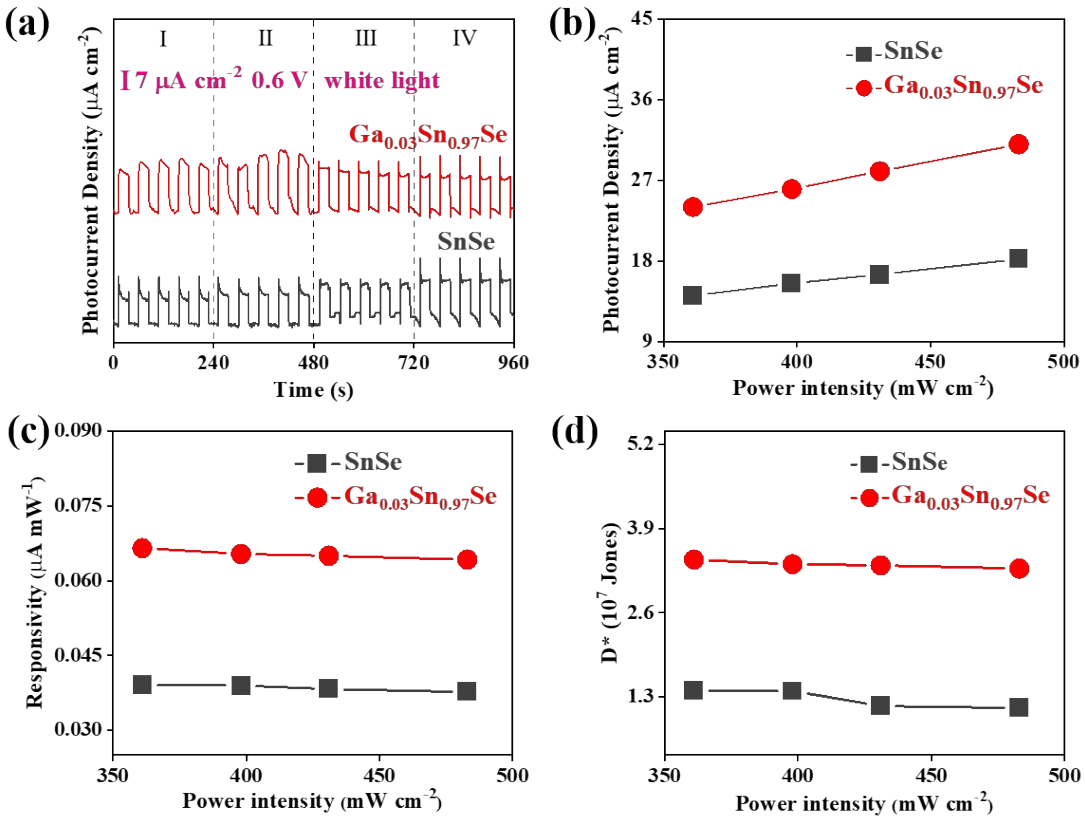

Fig. S8 (a) Photo-response of SnSe/$Ga_{0.03}Sn_{0.97}Se$-based PEC photodetectors under the illumination of white light with different power intensities. (b) Corresponding I_{ph}, (c) the calculated R_{ph}, (d) and D* of SnSe/$Ga_{0.03}Sn_{0.97}Se$-based photodetector.

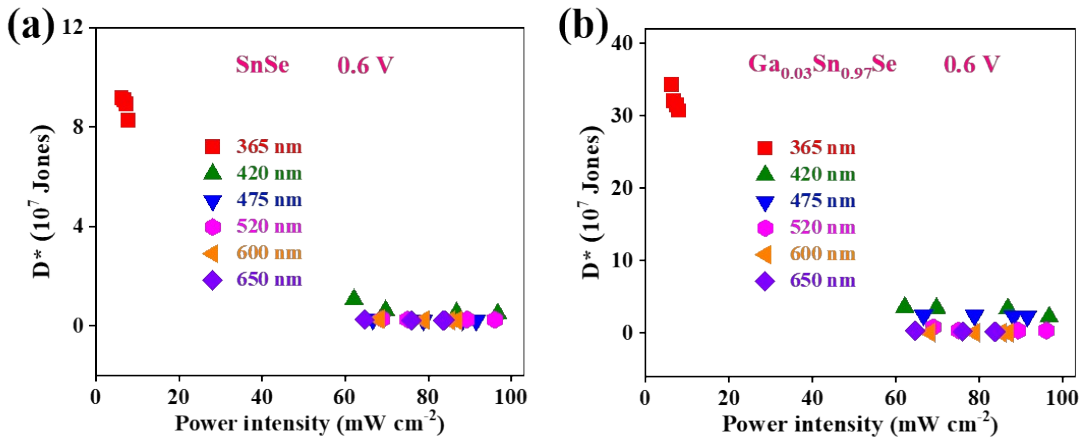

Fig. S9 The D* of SnSe/$Ga_{0.03}Sn_{0.97}Se$-based photodetector illuminated by various wavelengths of light with different power intensities.

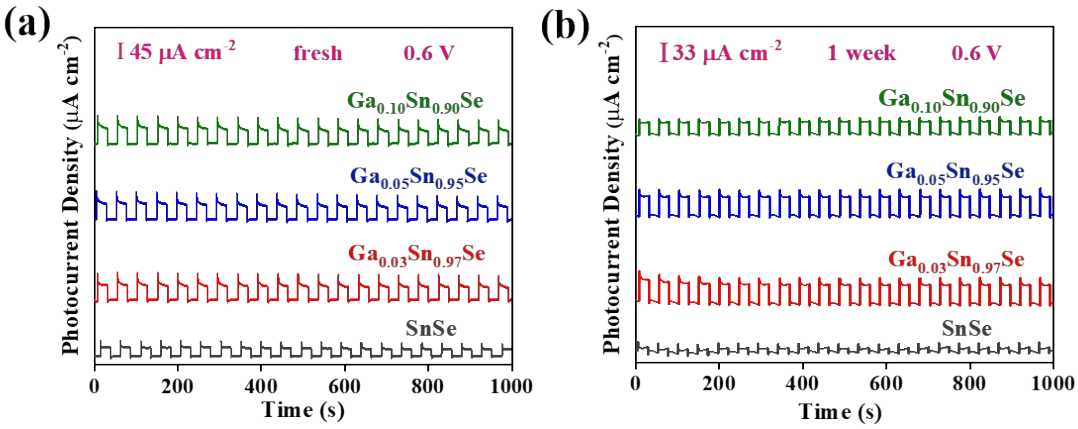

Fig. S10 Time stability test of SnSe/$Ga_xSn_{1-x}Se$-based PEC photodetector with time duration of one week in 0.5 M KOH.

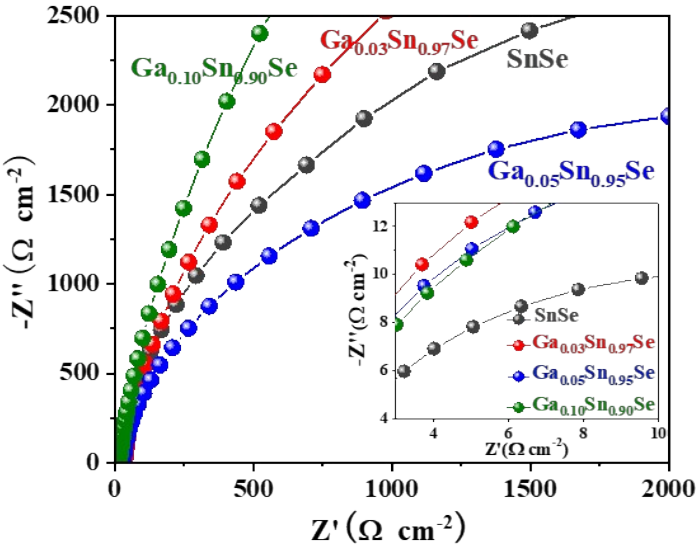

Fig. S11 The EIS curves of SnSe/$Ga_xSn_{1-x}Se$-based PEC photodetector (Inset: enlarged image of the high-frequency part).

Table S1. PEC Photo-response parameters of SnSe/$Ga_xSn_{1-x}Se$-based PEC photodetectors.

System		I ($\mu A\ cm^{-2}$)	P ($mW\ cm^{-2}$)	R ($\mu A\ mW^{-1}$)	D* (10^7 Jones)
SnSe	0.6 V	28.90	600	0.05	1.17
	0.4 V	18.81	600	0.03	1.34
	0.2 V	10.74	600	0.02	1.22
	0 V	4.32	600	0.01	0.88
	365 nm	3.20	6.17	0.52	3.01
	420 nm	4.01	87	0.05	0.87
	475 nm	3.10	95	0.03	0.19
	520 nm	1.30	88.50	0.01	0.21
	600 nm	0.27	94.20	0.00	0
	650 nm	0.20	87.90	0.00	0
$Ga_{0.03}Sn_{0.97}Se$	0.6 V	114	600	0.19	3.31
	0.4 V	85.30	600	0.14	3.04
	0.2 V	64.16	600	0.11	2.67
	0 V	41.66	600	0.07	2.06
	365 nm	9.86	6.17	1.60	26.4
	420 nm	13.23	87	0.15	2.74
	475 nm	6.57	95	0.07	1.39
	520 nm	2.50	88.50	0.03	0.63
	600 nm	1.35	94.20	0.01	0.21
	650 nm	0.90	87.90	0.01	0.22
$Ga_{0.05}Sn_{0.95}Se$	0.6 V	48.39	600	0.08	1.72
	0.4 V	41.60	600	0.07	1.94
	0.2 V	30	600	0.05	1.89
	0 V	18.30	600	0.03	1.83
	365 nm	7.80	6.17	1.26	22.70

	420 nm	7.92	87	0.09	1.86
	475 nm	6.46	95	0.07	1.52
	520 nm	2.30	88.50	0.03	0.69
	600 nm	1.10	94.20	0.01	0.23
	650 nm	0.82	87.90	0.01	0.24
$Ga_{0.10}Sn_{0.90}Se$	0.6 V	43.16	600	0.07	1.97
	0.4 V	29.30	600	0.05	1.76
	0.2 V	27.39	600	0.05	2.07
	0 V	15.75	600	0.03	1.54
	365 nm	7.24	6.17	1.17	13.3
	420 nm	7.30	87	0.08	1.04
	475 nm	4.72	95	0.05	1.07
	520 nm	1.91	88.50	0.02	0.51
	600 nm	0.37	94.20	0.00	0
	650 nm	0.23	87.90	0.00	0

Table S2. PEC Photo-response parameters of SnSe-based PEC photodetectors under various wavelengths with different light densities.

SnSe		I ($\mu A\ cm^{-2}$)	P ($mW\ cm^{-2}$)	R ($\mu A\ mW^{-1}$)	D* (10^7 Jones)
white light	I	14.1	361	0.039	1.4
	II	15.5	398	0.0389	1.39
	III	16.49	431	0.038	1.16
	IV	18.2	483	0.0377	1.13
365 nm	I	1.1	6.21	0.177	9.15
	II	1.2	6.81	0.176	9.07
	III	1.3	7.38	0.176	8.92
	IV	1.31	7.88	0.166	8.25
420 nm	I	1.34	62.1	0.022	1.06

	II	1.38	69.7	0.02	0.63
	III	1.52	86.8	0.0175	0.52
	IV	1.56	96.7	0.0161	0.48
475 nm	I	0.55	66.6	0.008	0.26
	II	0.59	78.8	0.007	0.22
	III	0.63	88.1	0.007	0.21
	IV	0.65	91.5	0.007	0.21
520 nm	I	0.52	68.9	0.0075	0.27
	II	0.56	75	0.00746	0.26
	III	0.66	89.3	0.0074	0.26
	IV	0.70	96	0.0073	0.24
600 nm	I	0.42	68.1	0.0062	0.26
	II	0.46	78.8	0.0058	0.23
	III	0.47	85.1	0.0055	0.21
	IV	0.49	86.8	0.0056	0.21
650 nm	I	0.36	64.6	0.0055	0.25
	II	0.37	76	0.0049	0.22
	III	0.38	83.5	0.0045	0.21
	IV	0.39	83.9	0.0046	0.21

Table S3. PEC Photo-response parameters of $Ga_xSn_{1-x}Se$-based PEC photodetectors under various wavelengths with different light densities.

$Ga_{0.03}Sn_{0.97}Se$		I ($\mu A\ cm^{-2}$)	P ($mW\ cm^{-2}$)	R ($\mu A\ mW^{-1}$)	D* (10^7 Jones)
white light	I	24	361	0.066	3.42
	II	26	398	0.0653	3.35
	III	28	431	0.065	3.33
	IV	31	483	0.0663	3.28

365 nm	I	5.707	6.21	0.919	34.3
	II	6.1	6.81	0.896	32
	III	6.38	7.38	0.864	31.5
	IV	6.8	7.88	0.863	30.7
420 nm	I	5.97	62.1	0.096	3.54
	II	6.63	69.7	0.095	3.43
	III	8.2	86.8	0.094	3.36
	IV	9.02	96.7	0.093	2.22
475 nm	I	2.99	66.6	0.045	2.44
	II	3.5	78.8	0.044	2.4
	III	3.87	88.1	0.0439	2.34
	IV	4	91.5	0.0437	2.31
520 nm	I	1.5	68.9	0.022	0.78
	II	1.6	75	0.0021	0.34
	III	1.8	89.3	0.02	0.32
	IV	1.9	96	0.0197	0.32
600 nm	I	0.121	68.1	0.0018	0.04
	II	0.14	78.8	0.0018	0.04
	III	0.15	85.1	0.00176	0.03
	IV	0.152	86.8	0.00175	0.03
650 nm	I	0.37	64.6	0.0057	0.30
	II	0.38	76	0.005	0.21
	III	0.415	83.5	0.00497	0.20
	IV	0.416	83.9	0.00496	0.18