Supporting Information

# Enhanced Two-Photon Absorption in Hydrothermally Synthesized La$_2$O$_6$Te Nanorods for Visible Light Photo Detection

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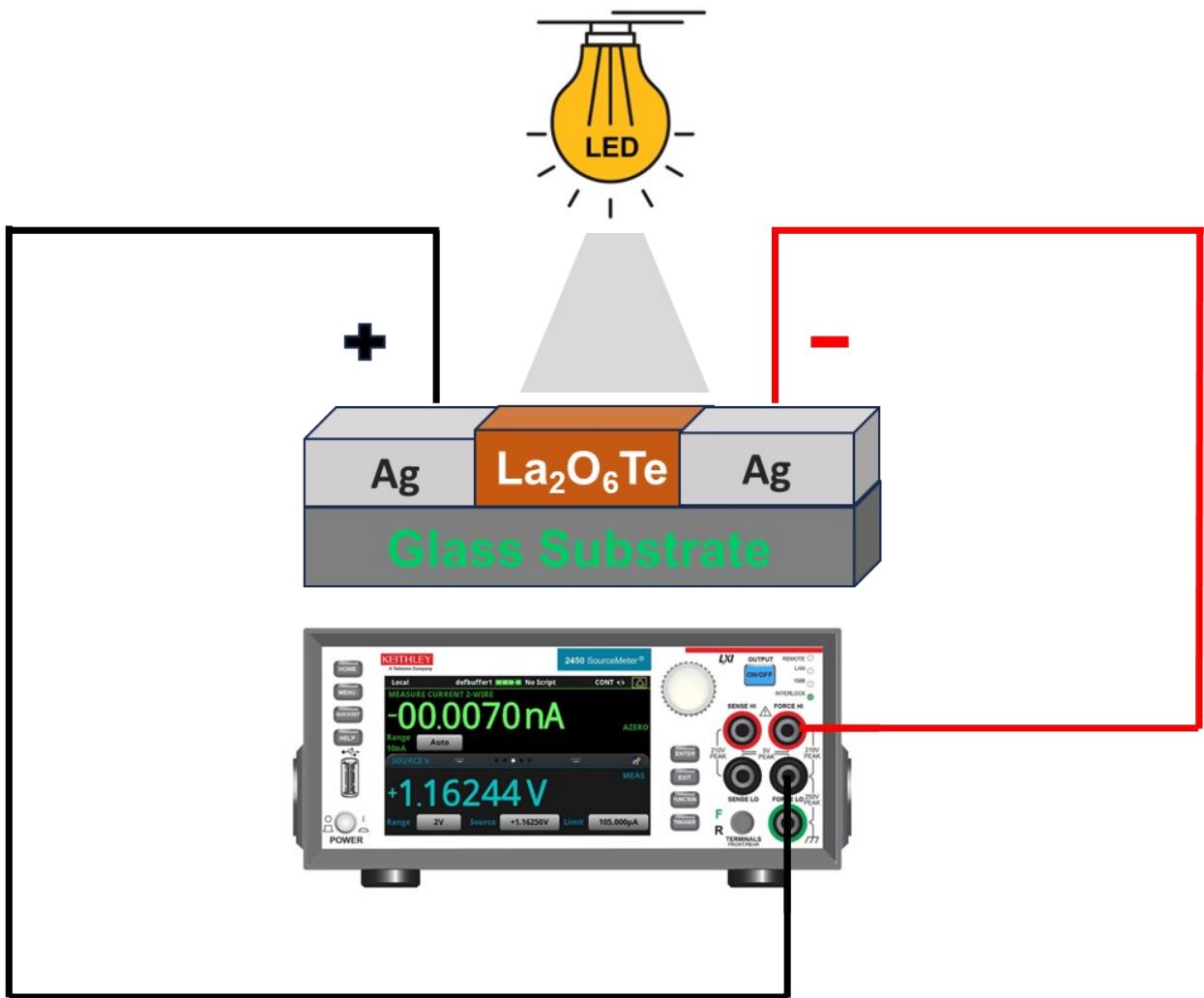
Scheme S1. Detailed photo detection measurement process of the fabricated PDs.
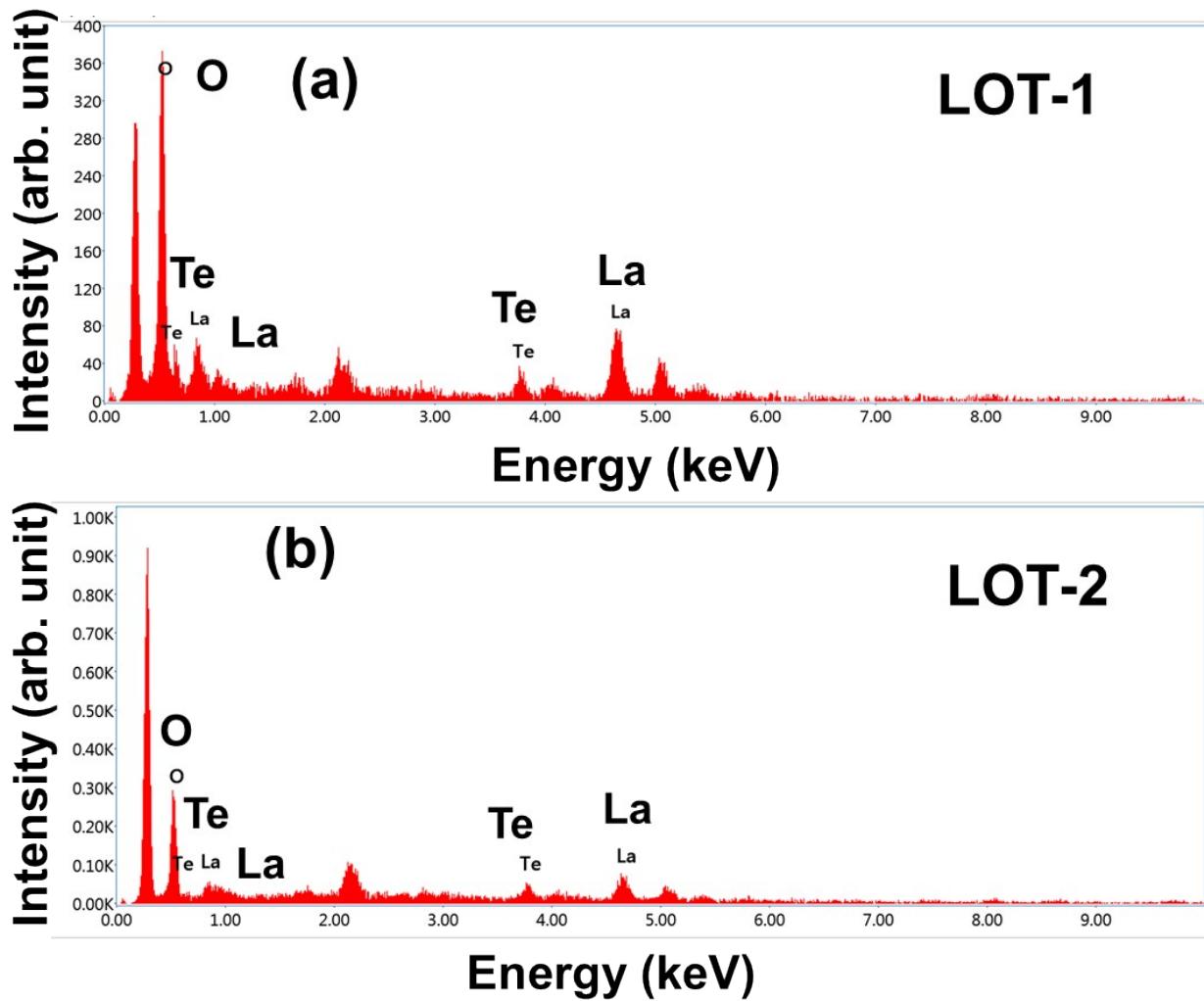
**Fig. S1.** EDX spectrum demonstrating the components present in each of the produced samples (a) LOT-1, and (b) LOT-2.
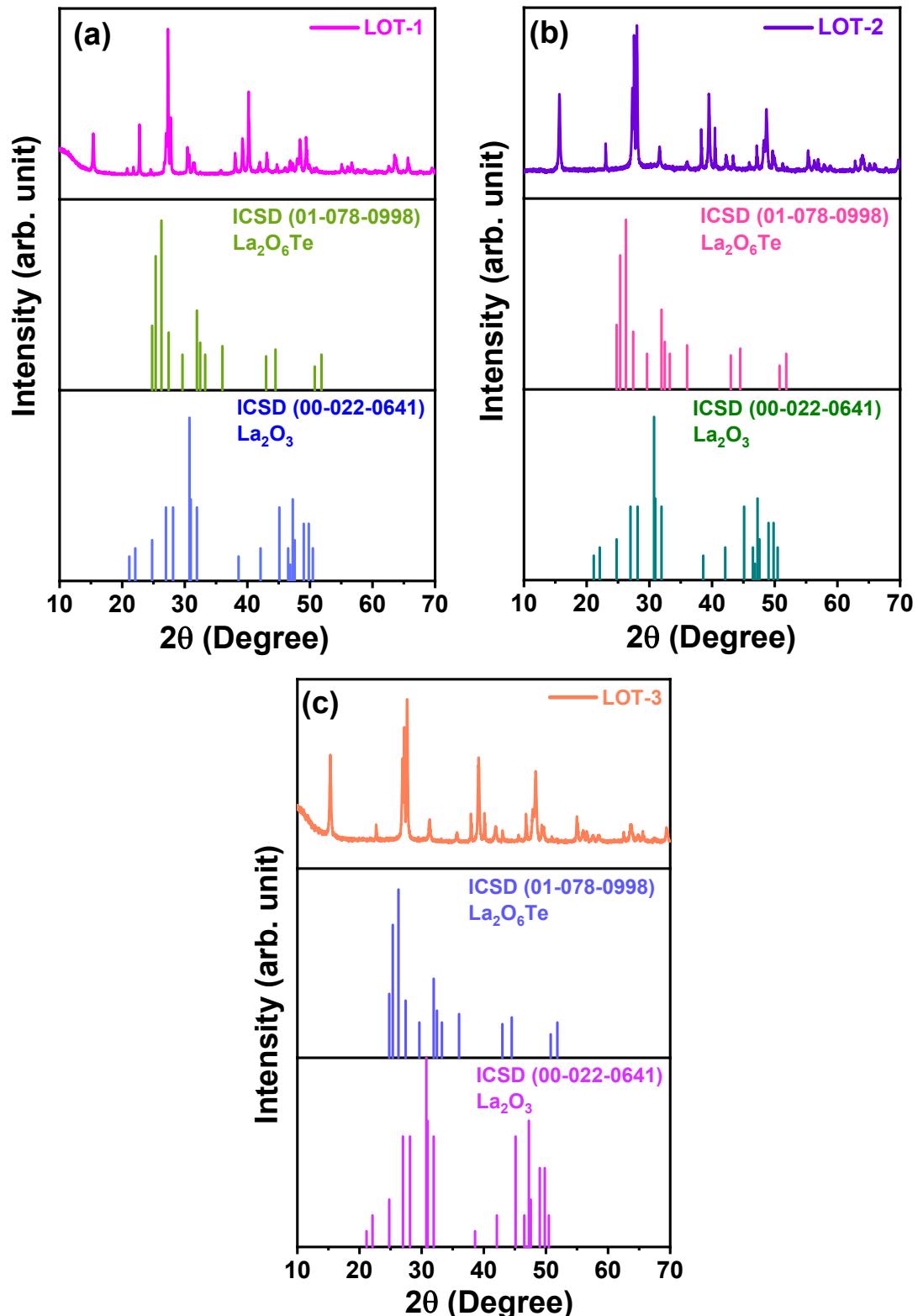
Fig. S2. XRD patterns of individual samples (a) LOT-1, (b) LOT-2 and (c) LOT-3 matched with the respective ICSD cards.
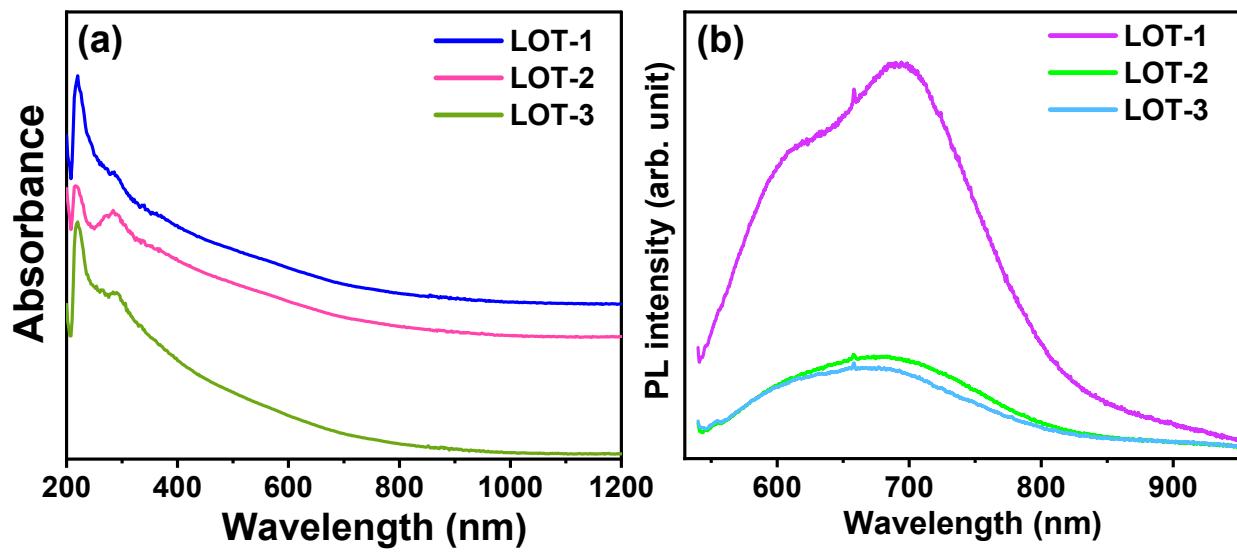
**Fig. S3.** (a) Absorbance spectra and (b) PL spectra of LOT samples.
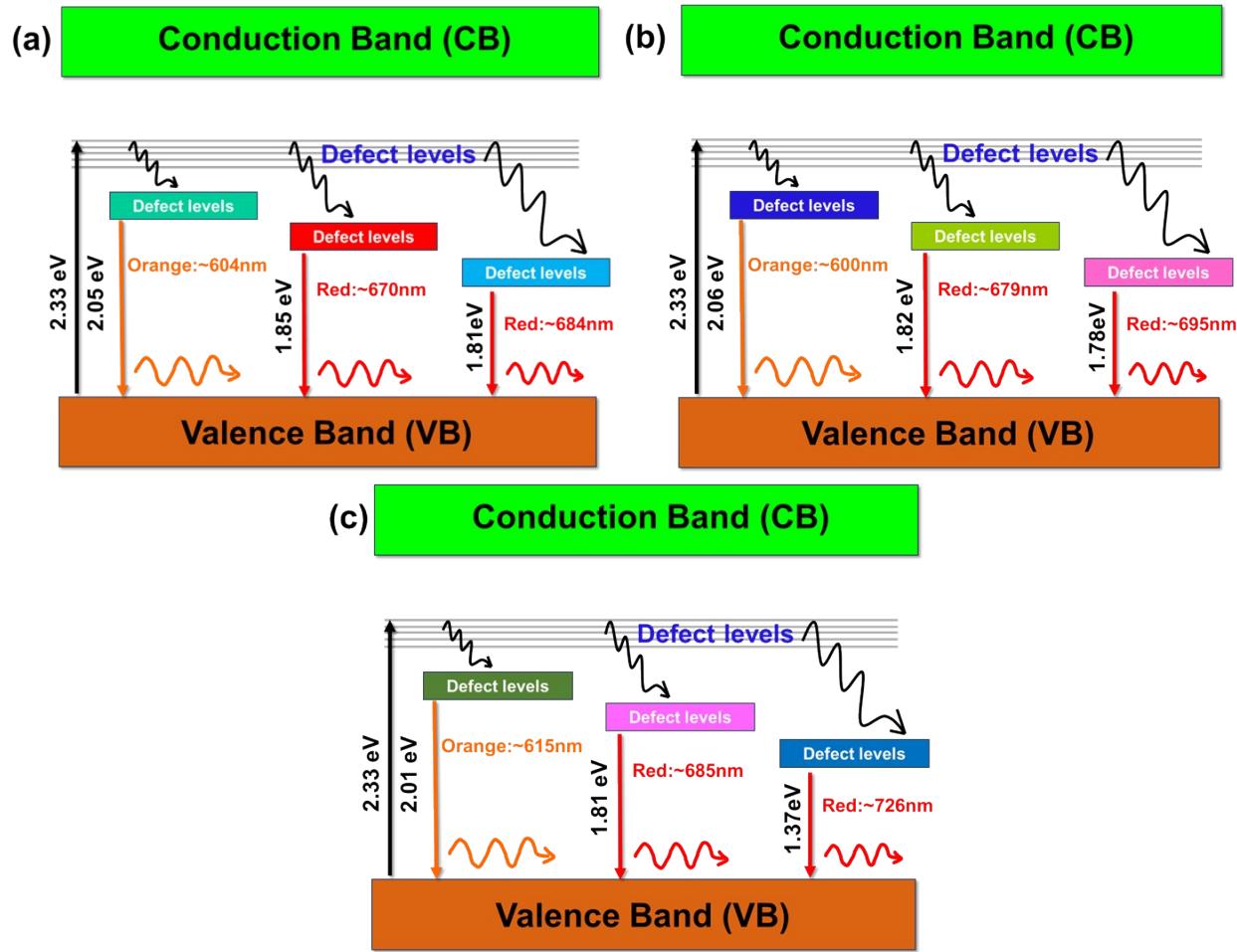
Fig. S4. Schematic illustration of the band gap diagram showing the defect energy states of (a) LOT-1, (b) LOT-2 and (c) LOT-3 samples.
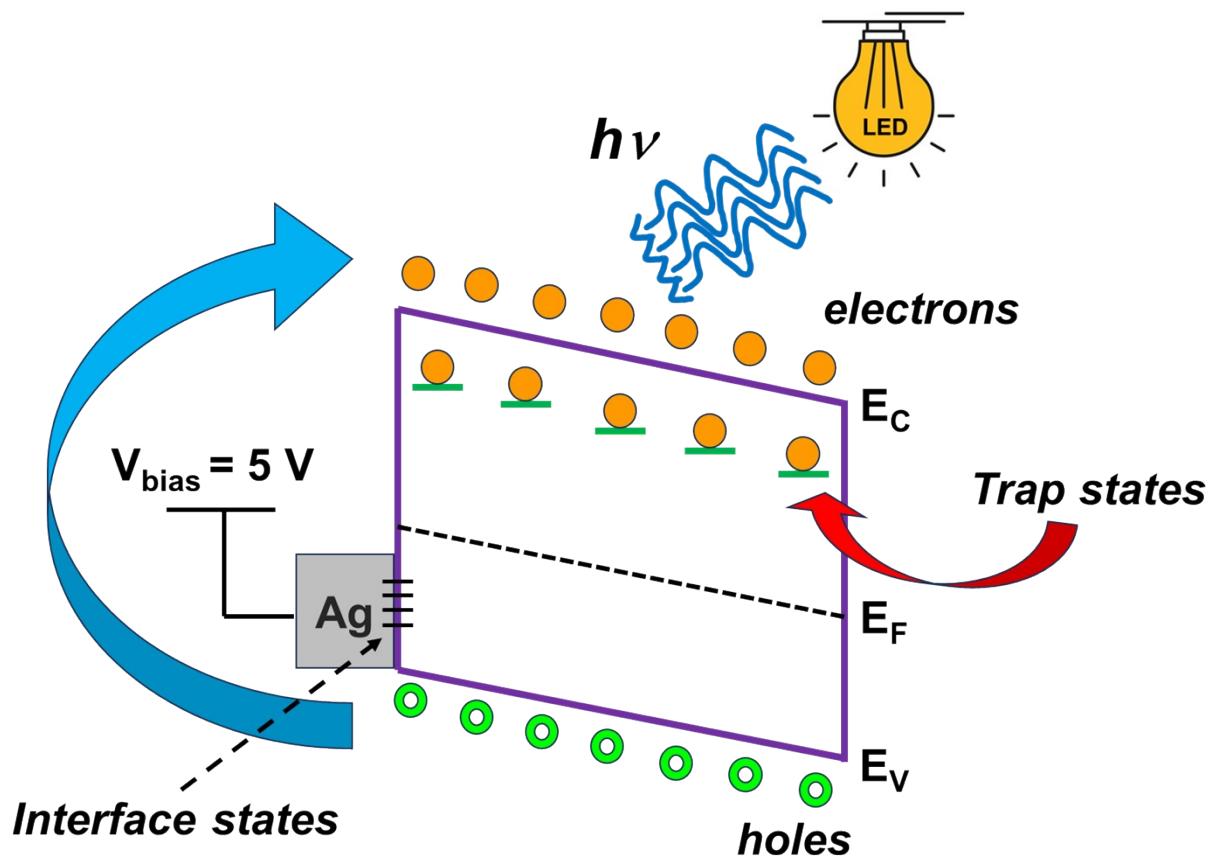
Fig. S5. Schematic diagram of the band structure representing the electron transport mechanism of LOT photodetection process.
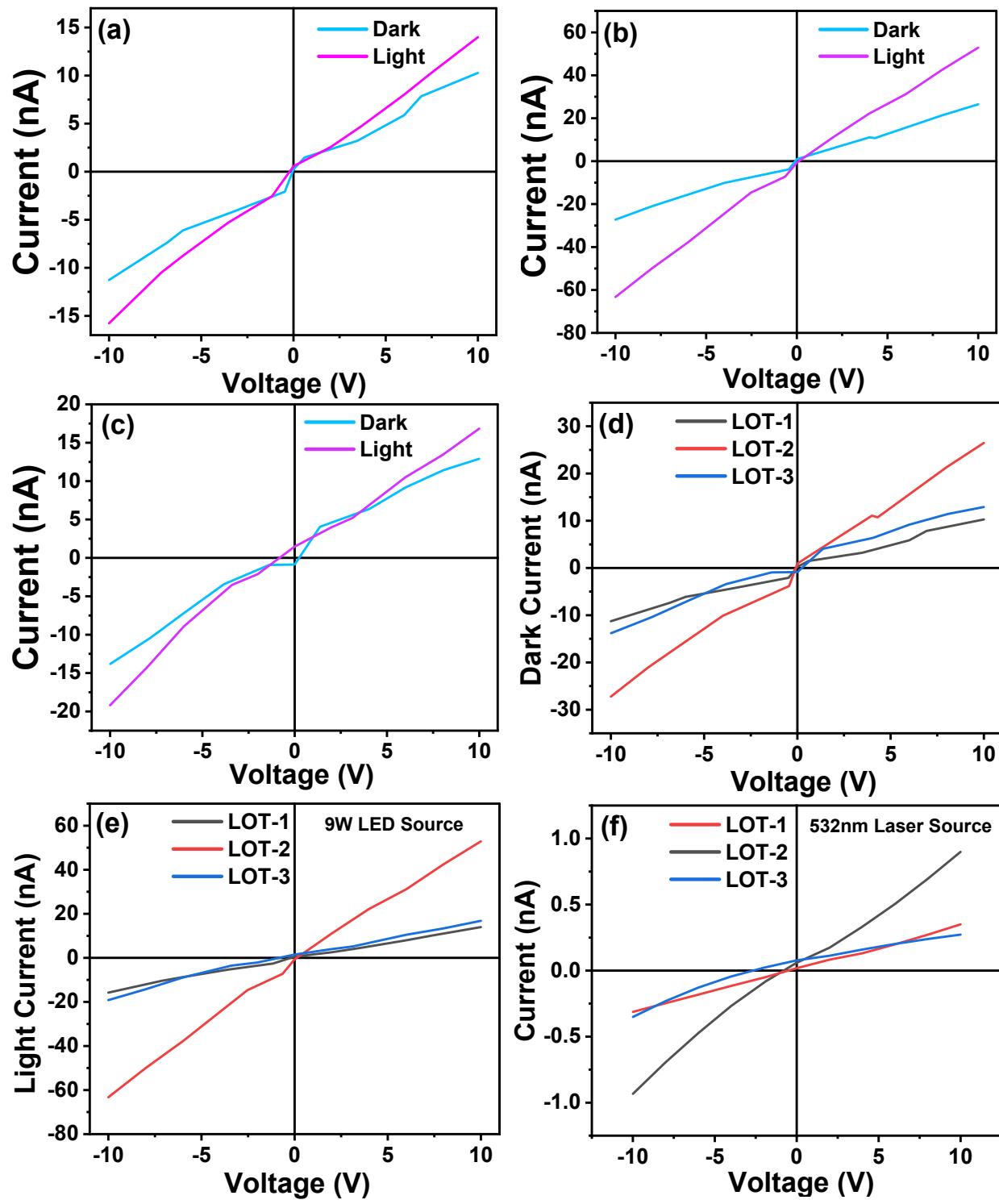
Fig. S6. I ~V characteristic plots showing the combined plot of all the samples in (d) dark circumstances and (e) light conditions, with the linear y-axis of the individual PDs of the sample (a) LOT-1, (b) LOT-2, and (c) LOT-3, respectively.
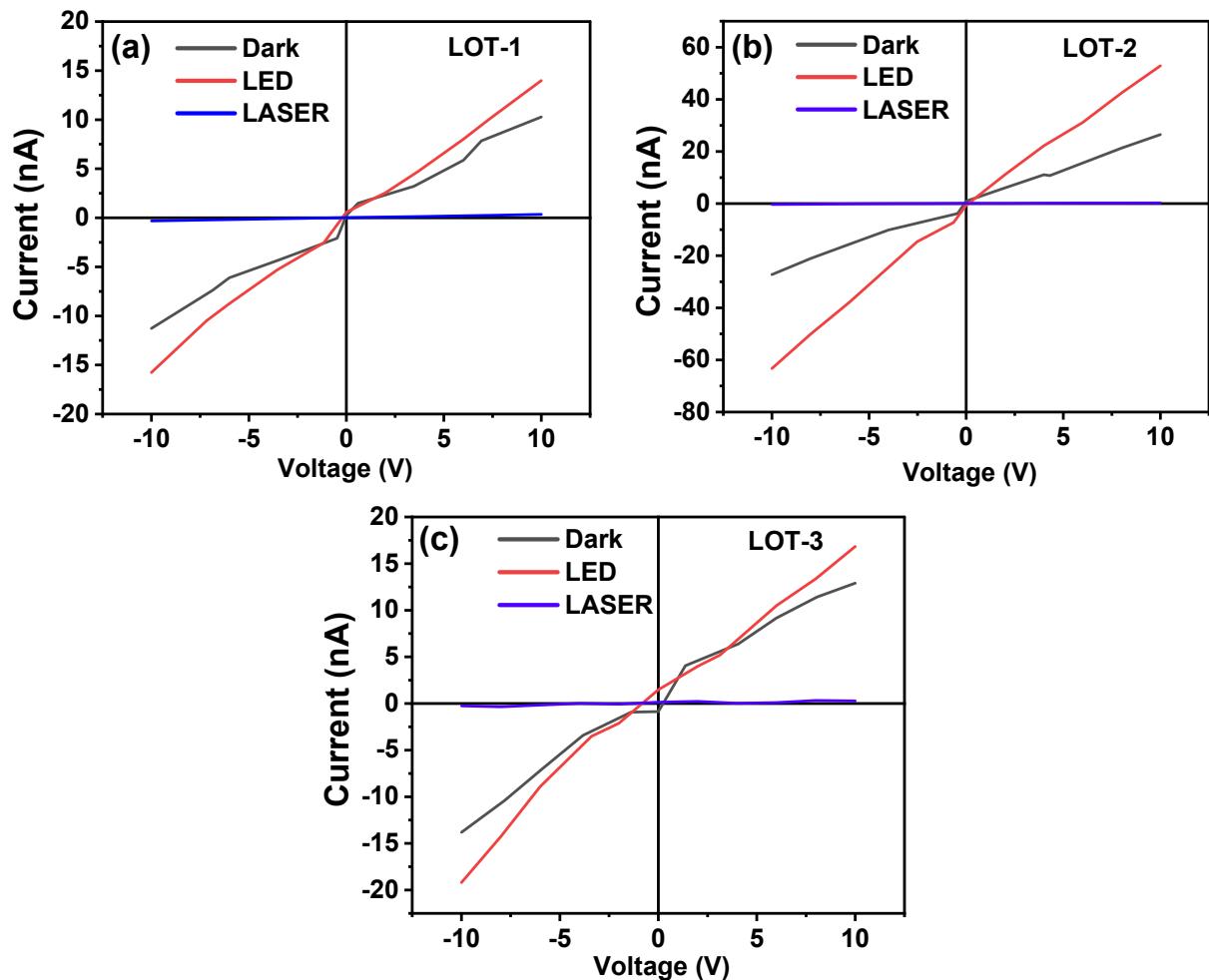
Fig. S7. I~V characteristics plots taken in dark, LED light and 532nm Laser light illumination conditions for (a) LOT-1, (b) LOT-2, and (c) LOT-3 samples.
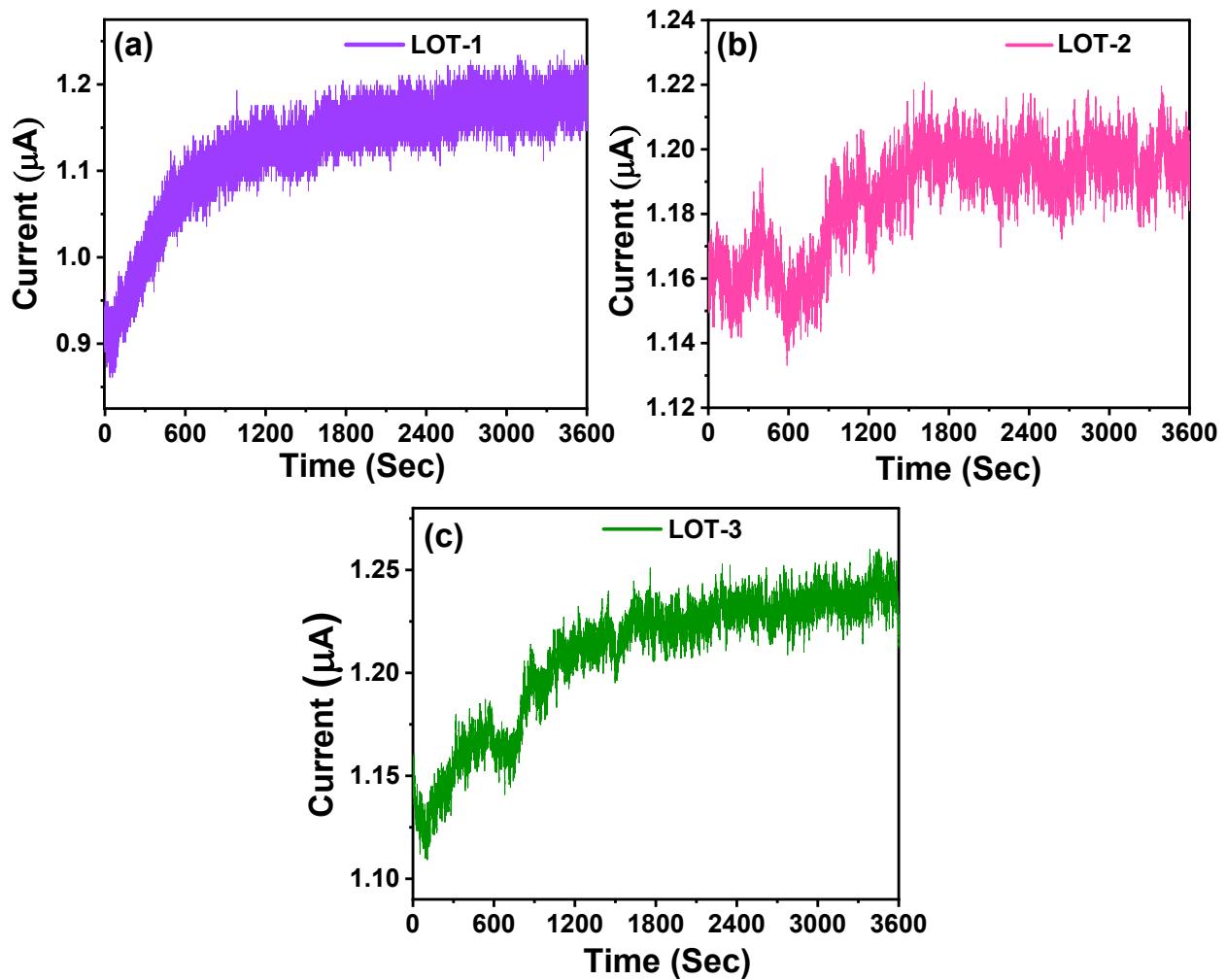
Fig. S8. I~T stability curve of (a) LOT-1, (b) LOT-2, and (c) LOT-3 samples taken for a period of 1 hour.

Table S1. Atomic percentage of various component elements of the samples.

| Sample	LOT-1	LOT-2	LOT-3
Element	At. %	At. %	At. %
La	76.82	75.32	78.73
O	12.53	13.76	10.84
Te	10.65	10.92	10.43
Total	100.00	100.00	100.00

Table S2. A summary of the photodetector performances of the typical 2D materials.

Photodetector materials	Wavelength (nm)	Responsivity (R) (AW^{-1})	Detectivity (D*) (Jones)	Refs.
Bi_2O_2S	850	9.48×10^{-3}	9.96×10^{10}	1
Bi_2O_2Se	300-900	3.712×10^3	3.3×10^{10}	2
Bi_2O_2Te	210-2400	3×10^5	4×10^{15}	3
Bi_2O_5Te	400-700 (Vis)	1.55×10^{-4}	2.18×10^{12}	4
GeP	532	~10^{-4}	1.38×10^7	5
O-doped BiI_3	532	0.23×10^3	2.52×10^{12}	6
La_2O_6Te	400-700 (Vis)	10.64×10^{-6}	5.8×10^7	This work

Table S3. NLO parameters of different materials under performed with CW laser mode.

Sample Name	β (cm/W)	n_2 (cm^2 / W)	$\chi^{(3)}$ (e.s.u.)	References
N-GO	0.14×10^{-6}	5.75×10^{-13}	3.25×10^{-7}	7
GO	2.1×10^{-6}	1.0203×10^{-11}	_	8
rGO	9×10^{-6}	9.5549×10^{-11}		
CDs	2.513×10^{-4}	1.012×10^{-8}	3.93×10^{-7}	9
THBSM crystal	2.014×10^{-3}	2.324×10^{-7}	7.504×10^{-5}	10
CdTe	1.4×10^{-2}	2.58×10^{-7}	_	11
Red-ZnCdSeS	2.25×10^{-4}	5.89×10^{-12}	8.05×10^{-14}	12
La$_2$O$_6$Te	3.798×10^{-3}	3.592×10^{-8}	5.826×10^{-3}	This work

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