Supplementary Information (SI) for Journal of Materials Chemistry C.

Supporting Information

Layered $Cs_3Bi_2I_9$ perovskite nanosheets on TiO_2 nanorods for high performance heterostructure photodetectors

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Figure Captions

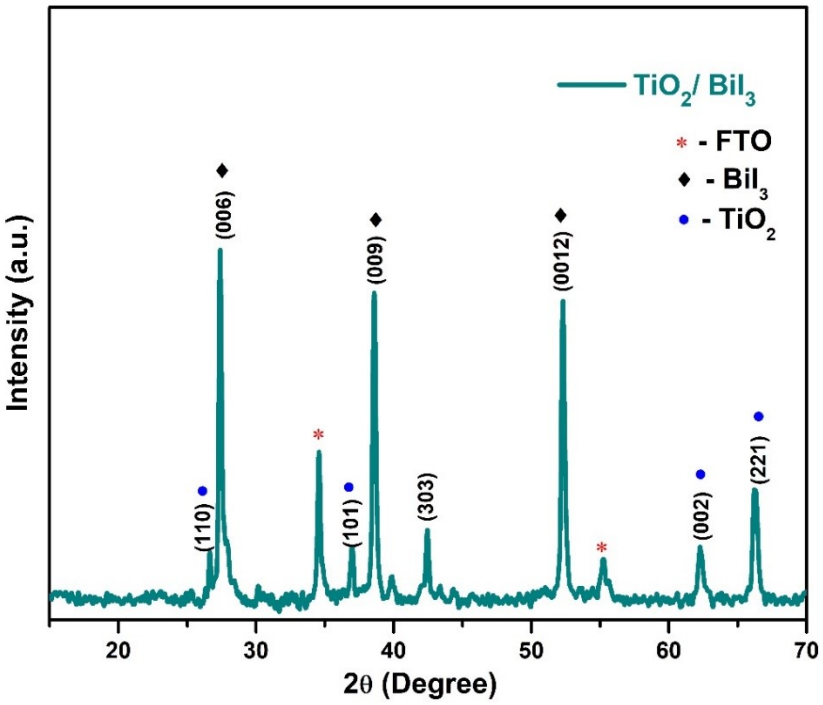
TiO2/ BiI3
* - FTO
♦ - BiI3
• - TiO2
Intensity (a.u.)
(006)
(009)
(0012)
(110)
(101)
(303)
(002)
(221)
20
30
40
50
60
70
2θ (Degree)

Fig.S1.

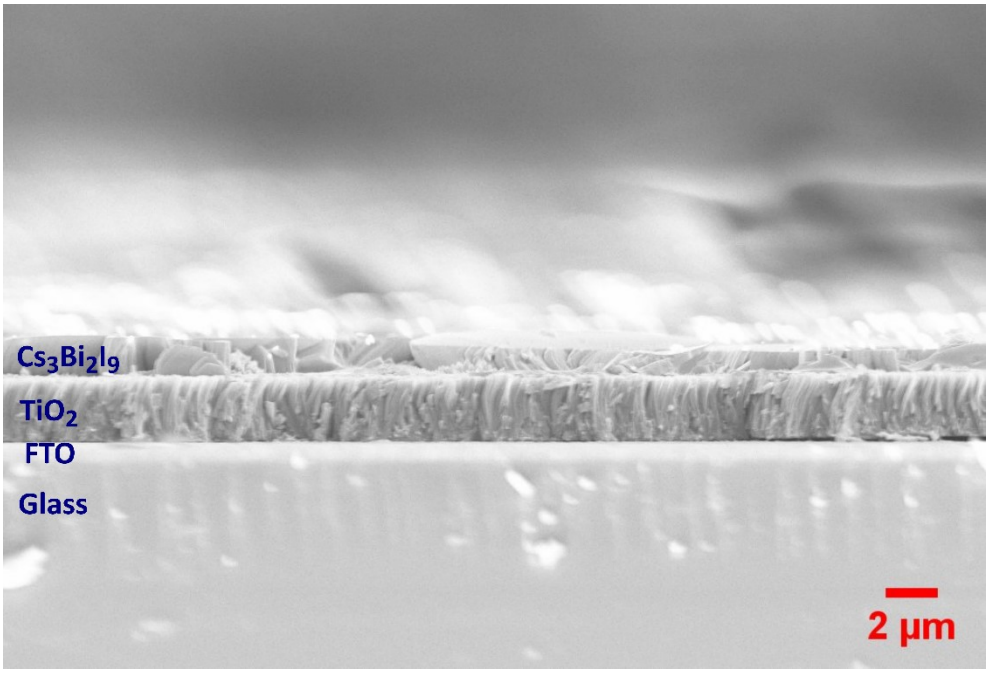

Fig. S2.

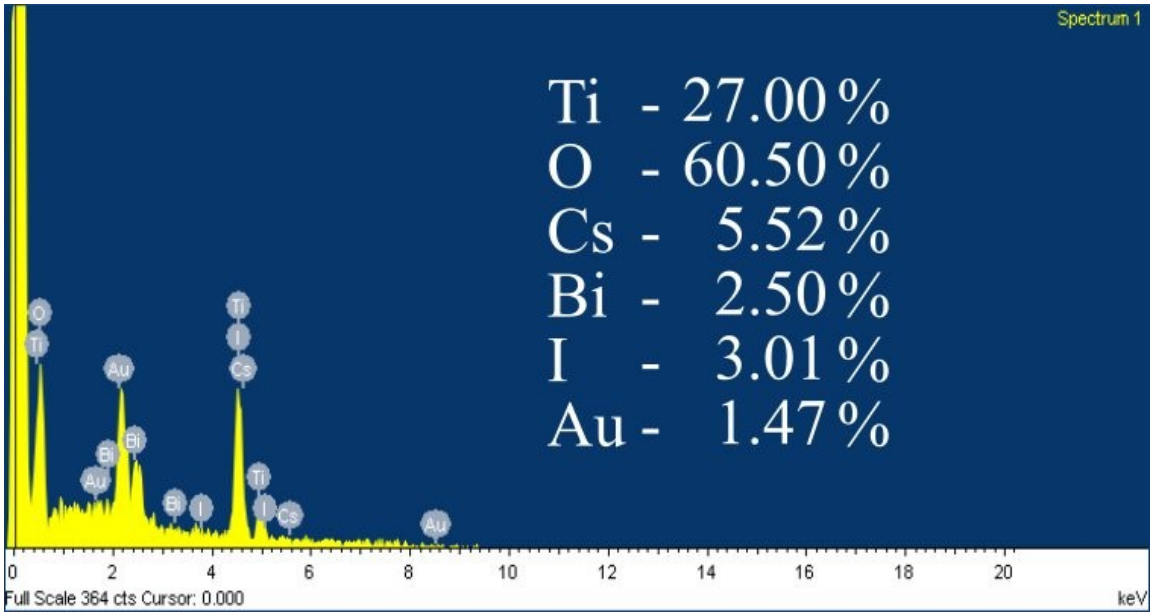
Spectrum 1
Ti - 27.00%
O - 60.50%
Cs - 5.52%
Bi - 2.50%
I - 3.01%
Au - 1.47%
O
Ti
Au
Bi
Au
Bi
I
Ti
I
Cs
Ti
I
Cs
Au
0
2
4
6
8
10
12
14
16
18
20
Full Scale 364 cts Cursor: 0.000
keV

Fig. S3.

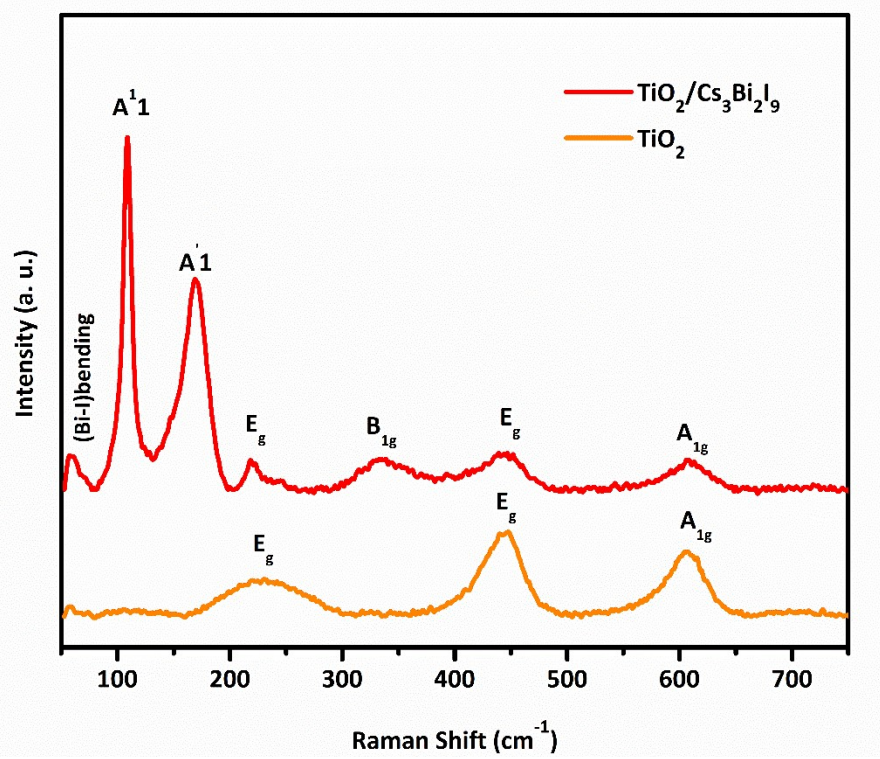
TiO2/Cs3Bi2I9
TiO2
A11
A'1
(Bi-I)bending
Eg
B1g
Eg
A1g
Eg
Eg
A1g
Intensity (a. u.)
100
200
300
400
500
600
700
Raman Shift (cm-1)

Fig.S4.

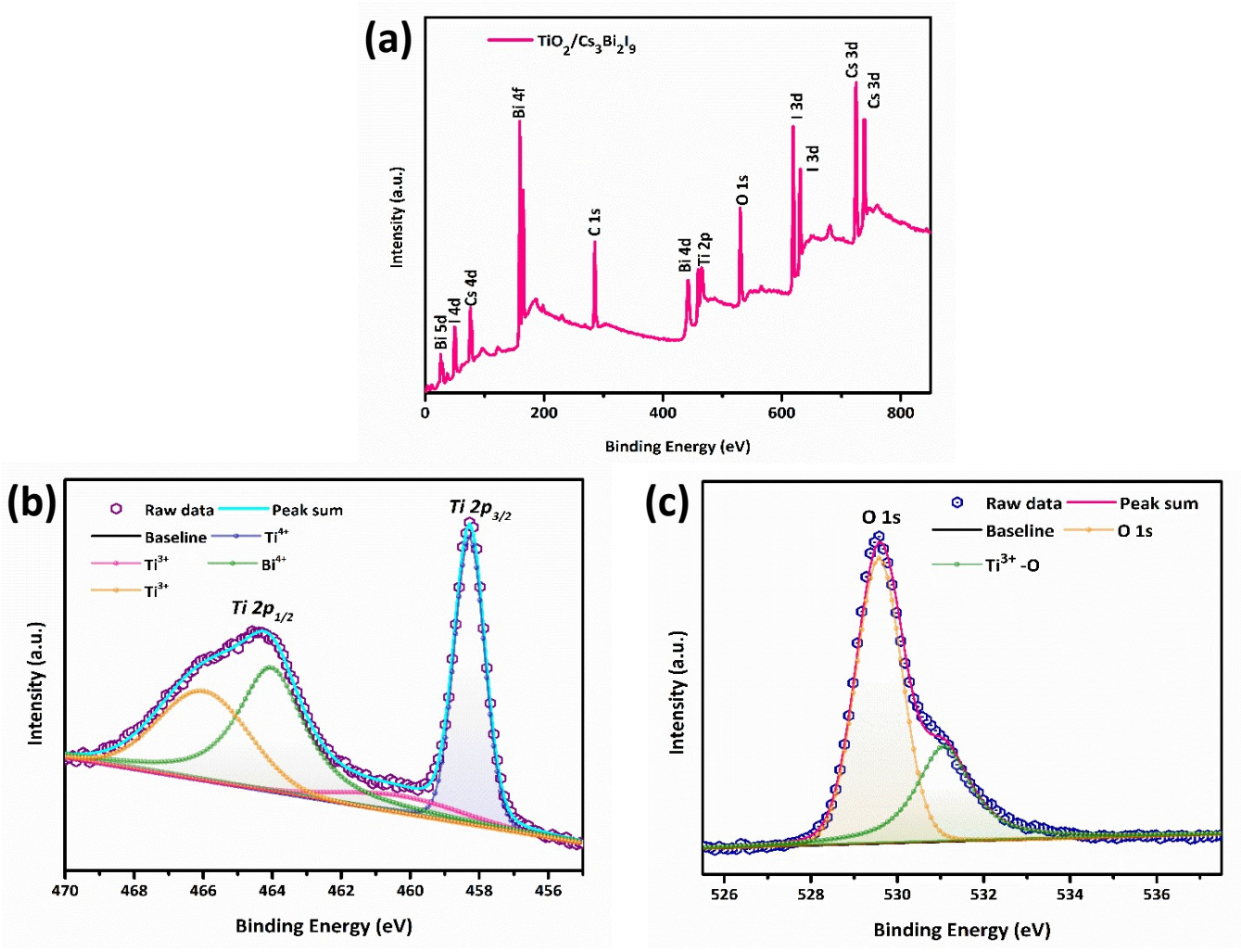
(a)
TiO2/Cs3Bi2I9
Intensity (a.u.)
Bi 5d
I 4d
Cs 4d
Bi 4f
C 1s
Bi 4d
Ti 2p
O 1s
I 3d
I 3d
Cs 3d
Cs 3d
0
200
400
600
800
Binding Energy (eV)
(b)
Raw data
Peak sum
Baseline
Ti4+
Ti3+
Bi4+
Ti3+
Ti 2p3/2
Ti 2p1/2
Intensity (a.u.)
470
468
466
464
462
460
458
456
Binding Energy (eV)
(c)
Raw data
Peak sum
Baseline
O 1s
Ti3+ -O
O 1s
Intensity (a.u.)
526
528
530
532
534
536
Binding Energy (eV)

Fig. S5.

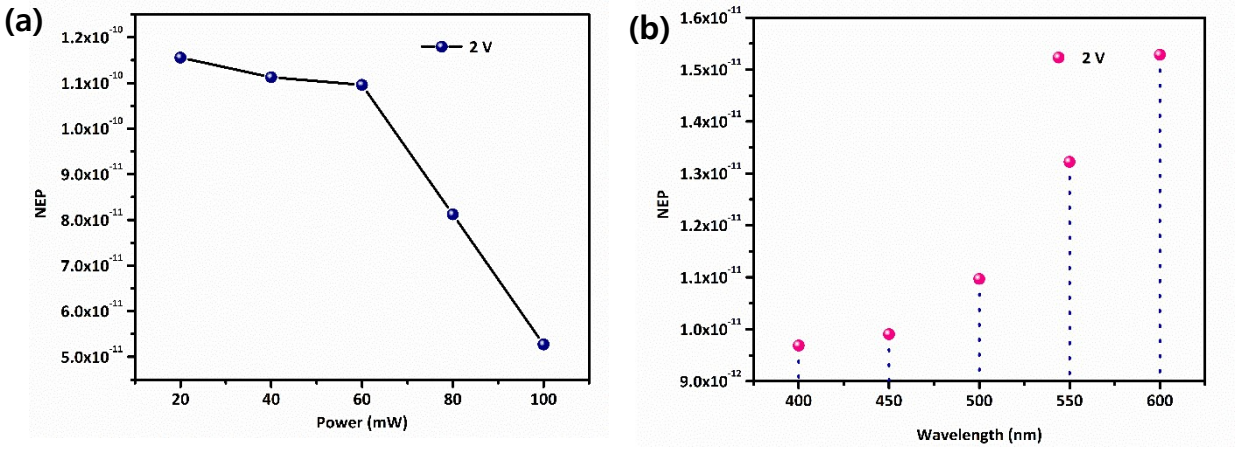

Fig. S6.

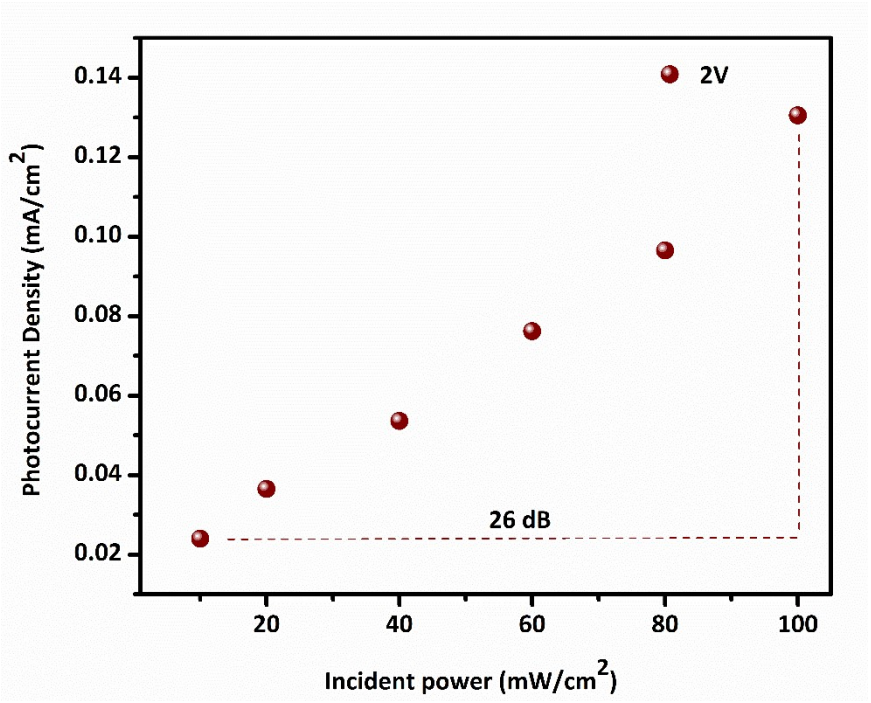
0.14
0.12
0.10
0.08
0.06
0.04
0.02
Photocurrent Density (mA/cm2)
2V
26 dB
20
40
60
80
100
Incident power (mW/cm2)

Fig. S7

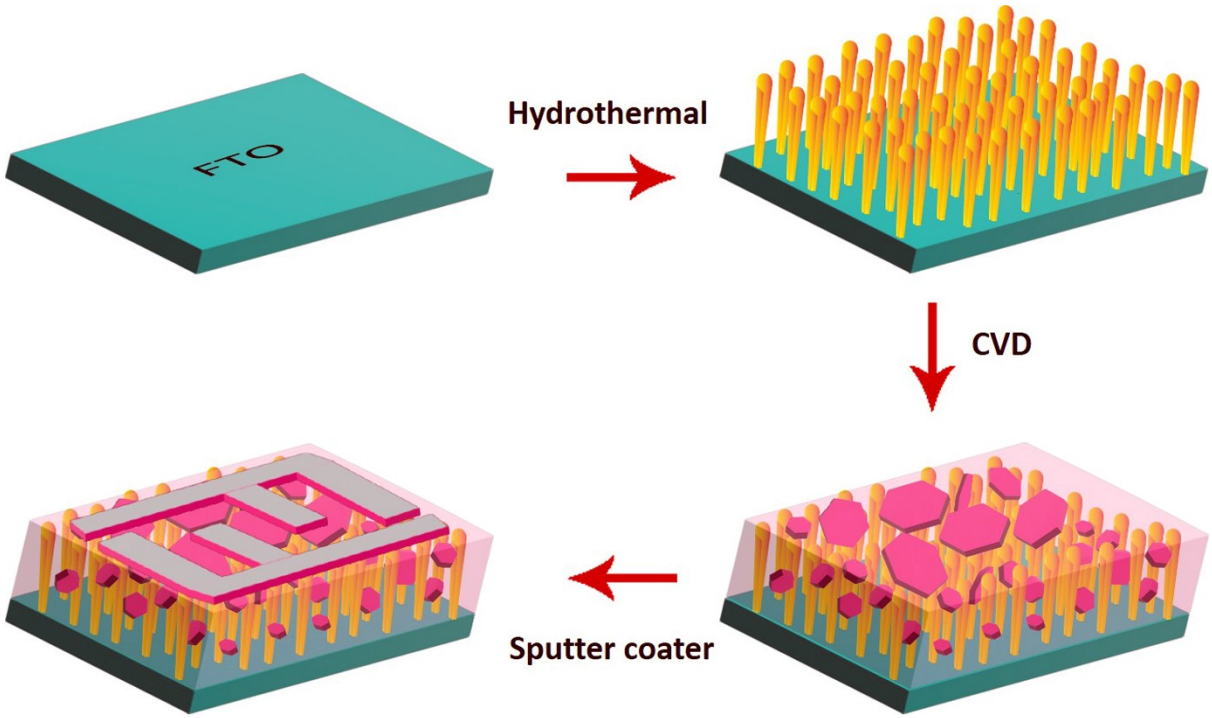

Fig. S8.

Table S1: The detailed comparison of parameters of perovskite based photodetectors

Device Structure	Type	Material Structure	Responsivity (A/W)	D*/10^8 Jones	EQE (%)	On/Off Ratio	Response Time/ms	Ref.
$TiO_2/Cs_3Bi_2I_9$	Photoconductor	Thin Films	1.1	19.69×10^2	291	3.72	200/400	This Work
ZnO/CsPbI3: PbSe/CuSCN	Photoconductor	Thin Films	9.24	3.17×10^6	-	-	76.8/82	1
Graphene–$CsPbBr_{3-x}I_x$/	Photoconductor	Nanocrystals	8.2×10^8	2.4×10^8	-	–	810/3650	2
$CsPbBr_3$	Photoconductor	Thin Films	55	0.9×10^5	16×10^3	10^5	0.43/0.318	3
$Cs_2AgBiBr_6$	Photoconductor	Thin Films	0.031	1.87×10^4	-	10^4	0.24/0.29	4
$CsPbBr_3$-ZnO	Photoconductor	Thin Films	4.25	–	-	10^4	0.21/0.24	5
$Cs_3Bi_2I_9$	Photoconductor	Thin Films	21.8	1.93×10^5	4×10^3	10^5	0.33/0.38	6
ZnO/PbSe:$CsPbBr_{1.5}I_{1.5}$/P3HT	Photodiode	Nanocrystals	6.16	5.96×10^{13}	18.22 at 532nm	10^4	350/375	7
$CsPbCl_3$	Photoconductor	Nanocrystals	1.89	–	-	10^3	41/43	8
$CsPbBr_3$	Photoconductor	Nano platelets	34	7.5×10^4	10^4	–	0.6/0.9	9
NiO_x/Nb_2CT_x/$MAPbI_3$/PCBM/BCP	photodiode	Thin Films	0.86 0.23	1.58×10^8 1.27×10^8	43.92 at 656 nm		0.02/0.09 0.014/0.002	10
$CsPbBr_3$	Photoconductor	Nanowires	–	–	-	10^3	100/100	11
$CsPbBr_3$–Au NCs	Photoconductor	Nanoparticles	0.01	4.56	16.69 at 532 nm	10^6	0.2/1.2	12
$CsPb(Br/I)_3$	Photoconductor	Nanorods	–	–	-	10^3	680/660	13
ZnO/CsSnBr3:P3HT/CuSCN	Photodiode	Nanocrystals	1.56	1.40×10^6	56.42 at 532 nm	-	-	14
$CsPbCl_3$	Photoconductor	Micro-wire	0.0143	–	-	2×10^3	3.212/2.511	15
P3HT:PbS:CsPbBr3/Au/PMMA	Phototransistor	Nanocrystals	182 at 532 nm	1.09×10^6	-	-	-	16
$CsPbBr_3$	Photoconductor	Single Crystal	2.1	–	-	–	300/5000	17
2D $CsPbBr_3$	Photoconductor	Nano sheets	0.64	–	54	10^4	0.019/0.025	18
CsPbBr3	Photoconductor	Microcrystals	60000	10^5	2×10^7	–	0.5/1.6	19
$CsPbBr_3$	Photoconductor	Nanoribbons	18.4	6.1×10^4	-	8616	8.7/3.5	20
$CsPbBr_3$	Photoconductor	Nano-sheets	–	–	-	10^2	17.8/14.7	21
$CsPbBr_3$–$CsPb_2Br_5$	Photoconductor	Thin Films	0.375	2960	-	380	0.28/0.64	22
PTAA/PEIE/$CsPbIBr_2$/PCBM	Photodiode	Thin Films	0.28	9.7×10^4	57.1	–	2×10^{-5}	23
$CsPbX_3$/α-Si radial junction	Photodiode	Quantum Dots	0.054	–	50	2.1×10^3	0.48/1.03	24
spiro-OMeTAD/$CsPbBr_3$/SnO_2	Photodiode	Microcrystals	0.172	4.8×10^4	-	1.3×10^5	0.14/0.12	25
ZnO/$CsPbBr_3$/GaN	Photodiode	Thin Films	0.23	2.4×10^5	-	10^4	281/104	26
$Cs_3Sb_2Cl_9$	Photoconductor	Nanowires	3616	0.0125	1×10^3	–	130/230	27
$Cs_2AgBiBr_6$	Photoconductor	Thin Films	7.01	5660	2×10^3	2.2×10^4	0.956/0.995	28
Au/(DMEDA)BiI5/Au	Photoconductor	Single crystal	0.015	-	3.67	100	2×10^{-8}/1.2×10^6	29

$SnO_2/Cs_2AgBiBr_6$	Photoconductor	Thin Films	0.11	240	40	–	3/2	30
$CsPbBr_3$	Photoconductor	Micro particles	0.18	–	41 at 532 nm	8×10^3	1.8/1.0	31
ZnO/PbSe:ZnO/CsPbBr3: P3HT/P3HT	Photodiode	Quantum Dots	1.4	6.59×10^6	56.13 at 532 nm	10^5	1529/156/5	32
$CsPbBr_3$	Photoconductor	Microcrystals	2.1	–	485	10^3	0.25/0.45	33
$CsPbI_3$	Photoconductor	Nanocrystals	–	–	-	10^5	24/29	34
$CsPbI_3$	Photoconductor	Nanowires	0.0067	1.57	17 at 450 nm	–	292/234	34
$CsPbBr_3$	Photoconductor	Single Crystal	2	–	-	10^3	0.111/0.575	36
$CsPbBr_3$–CNTs	Photoconductor	Nano sheets	31.1	–	7×10^3	832	0.016/0.38	37
$CsPbBr_3$–ZnO NPs	Photoconductor	Thin Films	0.0115	–	-	12.86	409/17.92	38
α –$CsPbI_3$-$NaYF_4$:Yb,Er QDs	Photoconductor	Quantum Dots	1.5	–	-	10^4	5/5	39
MoS_2–$CsPbBr_3$	Photoconductor	Nano sheets	4.4	250	30.2 at 442 nm	10^4	0.72/1.01	40

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