Supporting Information

High performance and Self-Powered Photodetector Based on $Se/CsPbBr_3$ Heterojunction

Tianxu Zheng,[a] Qingyang Du,[a] Weiwei Wang,[a] Wei Duan,[a] Shiliang Feng,[a] Rongpeng Chen,[a] Xi Wan,

[a] Yanfeng Jiang [a] and Pingping Yu [*a]

a. Engineering Research Center of IoT Technology Applications (Ministry of Education), Department of Electronic Engineering, Institute of Advanced Technology, Jiangnan University, 1800 Lihu Avenue, Wuxi 214122, China.

* Corresponding Authors.

E-mail: pingpingyu@jiangnan.edu.cn

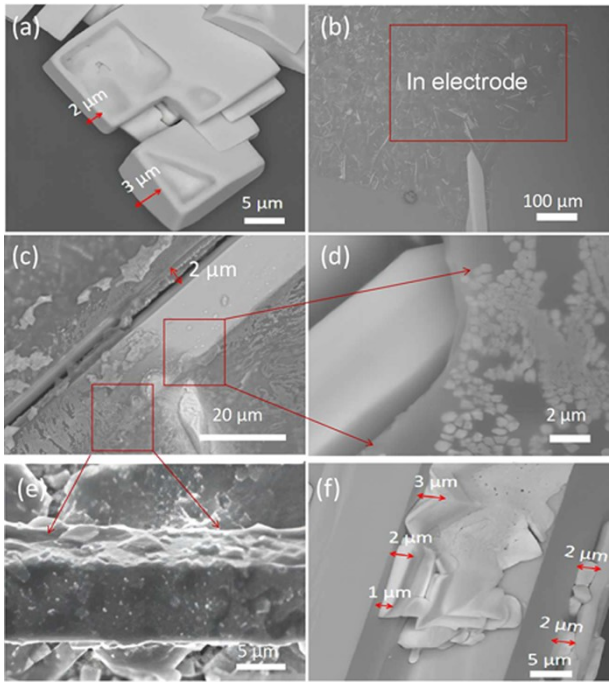

Fig. S1 SEM images of (a) CsPbBr3 and (b-f) Se/$CsPbBr_3$ at low and high magnification.

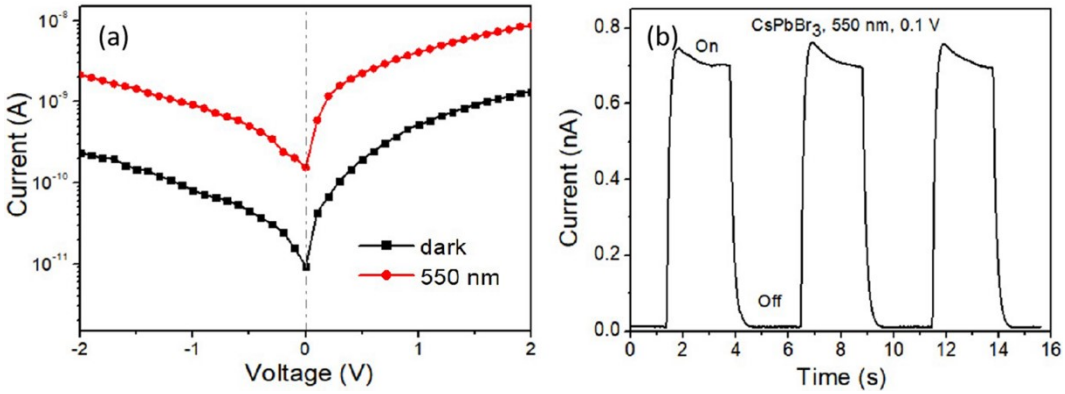

Fig. S2 (a) The I-V curves of $CsPbBr_3$ PD at dark and 550 nm, (b) I-t curves of $CsPbBr_3$ PD under 550 nm at 0.1 V bias.

In order to calculate the noise equivalent power (NEP) of the Se/$CsPbBr_3$ device, we measured the noise current of our detectors under a bias of 0.5, 1 and 2 V at different frequency (1-1000 Hz). The noise power spectrum is shown on Fig. S3. With a slope of approximately 1, the noise power spectrum of Se/$CsPbBr_3$ PD exhibits high 1/f dependency, which mostly restricts detectivity at low-frequency because of the flicker noise. At 1 Hz, S (f = 1Hz) is 9.34×10^{-28}, 2.97×10^{-26}, 1.24×10^{-25} A^2 Hz^{-1} at bias of 0.5, 1 and 2 V. The responsivity of Se/$CsPbBr_3$ PD is 0.8, 1.2 and 3.2 AW^{-1} with the different bias at 550 nm, respectively. Then, the NEP of Se/$CsPbBr_3$ PD is calculated to be 1.21×10^{-13}, 1.43×10^{-13} and 1.12×10^{-13} W $Hz^{-1/2}$ at the wavelength of 550 nm under a modulation frequency of 1 Hz at bias of 0.5, 1 and 2 V, which is lower sensitivity than the reported photodetectors (PbS/$CsPbBr_3$ PD of 0.14 pW $Hz^{-1/2}$, $CsPbBr_3$ PD of 1 pW $Hz^{-1/2}$, MoS_2 PD of 1.8 pW $Hz^{-1/2}$) [55-57]. According to the equation: $D^* = \frac{R\sqrt{AB}}{I_n} = \frac{\sqrt{AB}}{NEP}$, where I_n is the total noise current, A is the effective area of device, B is the measurement bandwidth. The specific detectivity D* is

2.61, 2.21 and 2.90×10 ^{10} Jones at bias of 0.5, 1 and 2 V. The parameter are listed in Table S1 and S2.

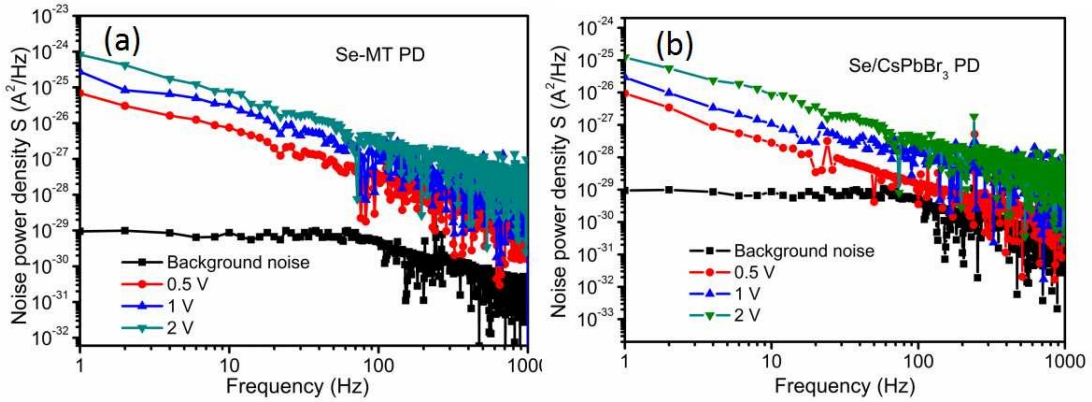

Fig. S3 Noise power density as a function of bias voltage of (a) Se-MT PD and (b) Se/$CsPbBr_3$ PD.

Table S1 The S(1 Hz), NEP and D* of Se-MT PD at 0.5, 1 and 2 V

Bias	S(1 Hz) (A^2 Hz^{-1})	R(A W^{-1})	NEP (W $Hz^{-1/2}$)	D* (Jones)
0.5 V	8.26×10^{-26}	0.1	2.87×10^{-12}	1.10×10^{9}
1 V	3.10×10^{-25}	0.6	9.27×10^{-13}	3.41×10^{9}
2 V	9.32×10^{-25}	1.2	8.05×10^{-13}	3.93×10^{9}

Table S2 The S(1 Hz), NEP and D* of Se/$CsPbBr_3$ PD at 0.5, 1 and 2 V

Bias	S(1 Hz) (A^2 Hz^{-1})	R(A W^{-1})	NEP (W $Hz^{-1/2}$)	D* (Jones)
0.5 V	9.34×10^{-28}	0.8	1.21×10^{-13}	2.61×10^{10}
1 V	2.97×10^{-26}	1.2	1.43×10^{-13}	2.21×10^{10}
2 V	1.24×10^{-25}	3.2	1.12×10^{-13}	2.90×10^{10}

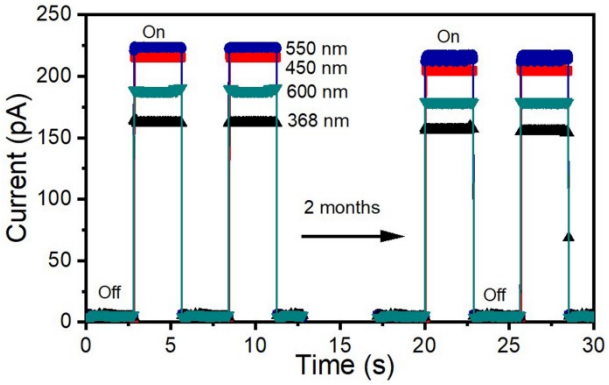

Fig. S4 The I-t curves of the Se/$CsPbBr_3$ PD after 2 months.