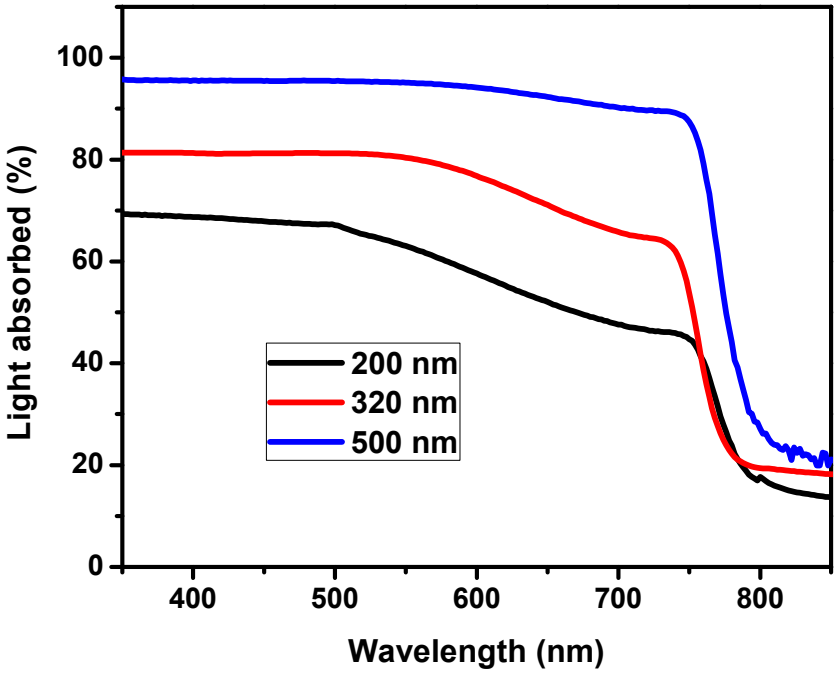
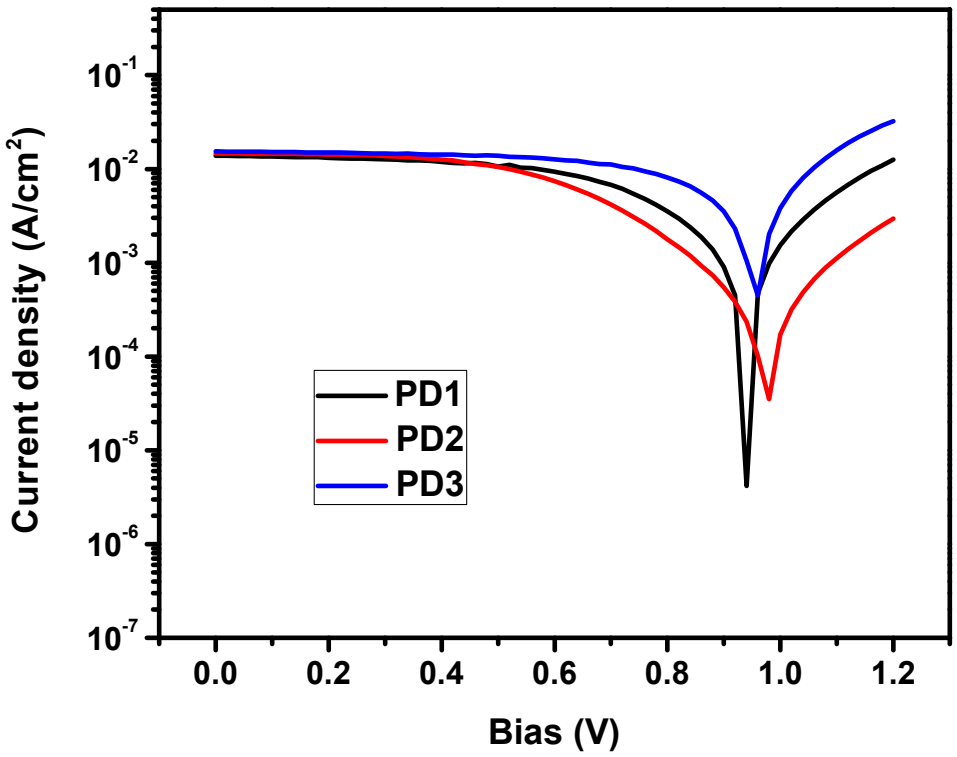
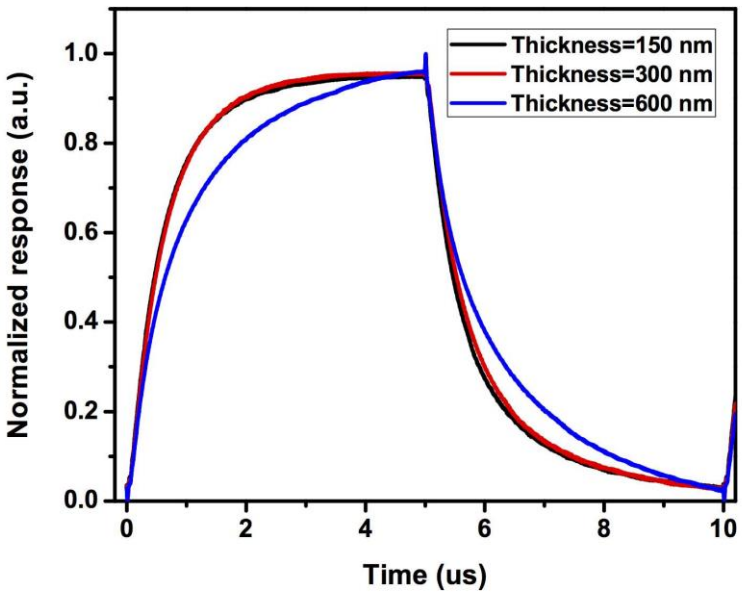
Supplementary Information



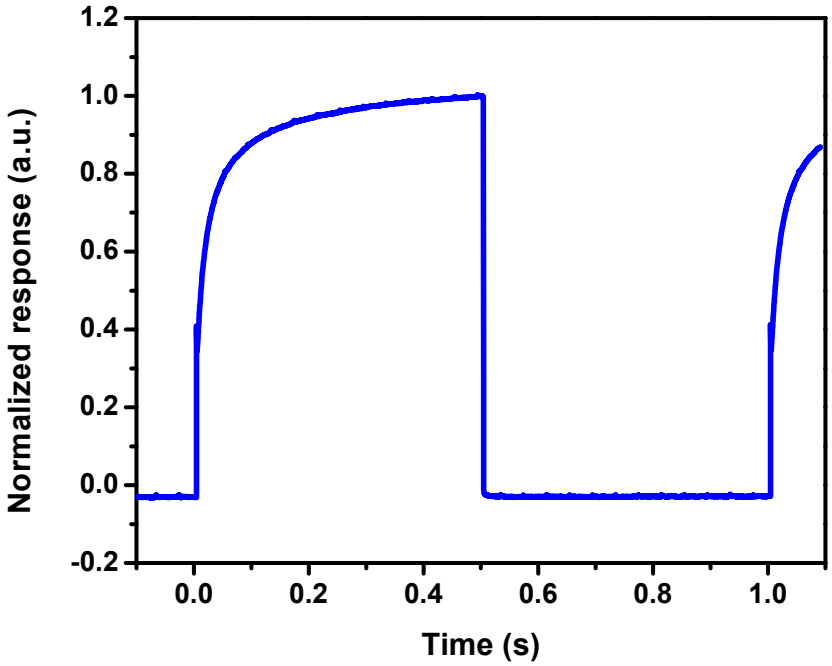
Supplementary Fig. 1| Absorption spectrum of the photodetector at different film thickness. For a film with thickness ~300 nm, more than 70% light can be absorbed in a single pass. When there is a metal electrode, the light within absorption range will be absorbed completely.



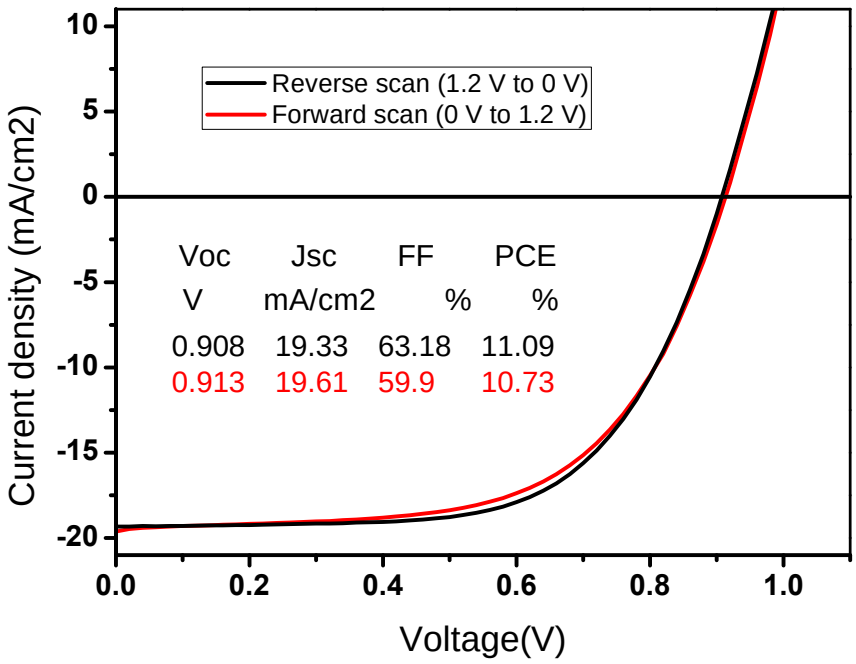
Supplementary Fig. 2| Current density-Votage curves of the photodetectors. PD1, without hole blocking layers; PD2, with BCP as hole blocking layer; and PD3, with PFN as hole blocking layer. The devices were measured under light a light intensity of 100 mW/cm^2.



Supplementary Fig. 3| Transient photocurrent response of the photodetectors. When the pervoskite layer thickness is too thick, the respond speed drops dramatically.



Supplementary Fig. 4| Transient photocurrent response of the photodetector PD4. The device structure is ITO/TiO_2/$CH_3NH_3PbI_{3-x}Cl_x$/p-doped spiro-MeOTAD/Au. The device has a response time of ~30 ms (reaching 70% of its maximum).



Supplementary Fig. 5| J-V curves of the device PD3 working in photovoltaic mode. PD3 has an "inverted" structure of ITO/PEDOT:PSS/$CH_3NH_3PbI_{3-x}Cl_x$ /PCBM/PFN/Al. The black and red curves indicate different scan direction (step 0.02 V, delay time 200 ms). The hysteresis effect in such device is less obvious compared to the hysteresis effect in regular device configuration (ITO/TiO_2/$CH_3NH_3PbI_{3-x}Cl_x$/p-doped spiro-MeOTAD/Au)[1].

References:

1. Snaith, H. J. *et al*. Anomalous Hysteresis in Perovskite Solar Cells. *J. Phys. Chem. Lett*. **5**, 1511 (2014).