Electronic Supplementary Information

# Energy gradient architectured praseodymium chalcogenide quantum dot solar cells: Towards unidirectionally funneling energy transfer

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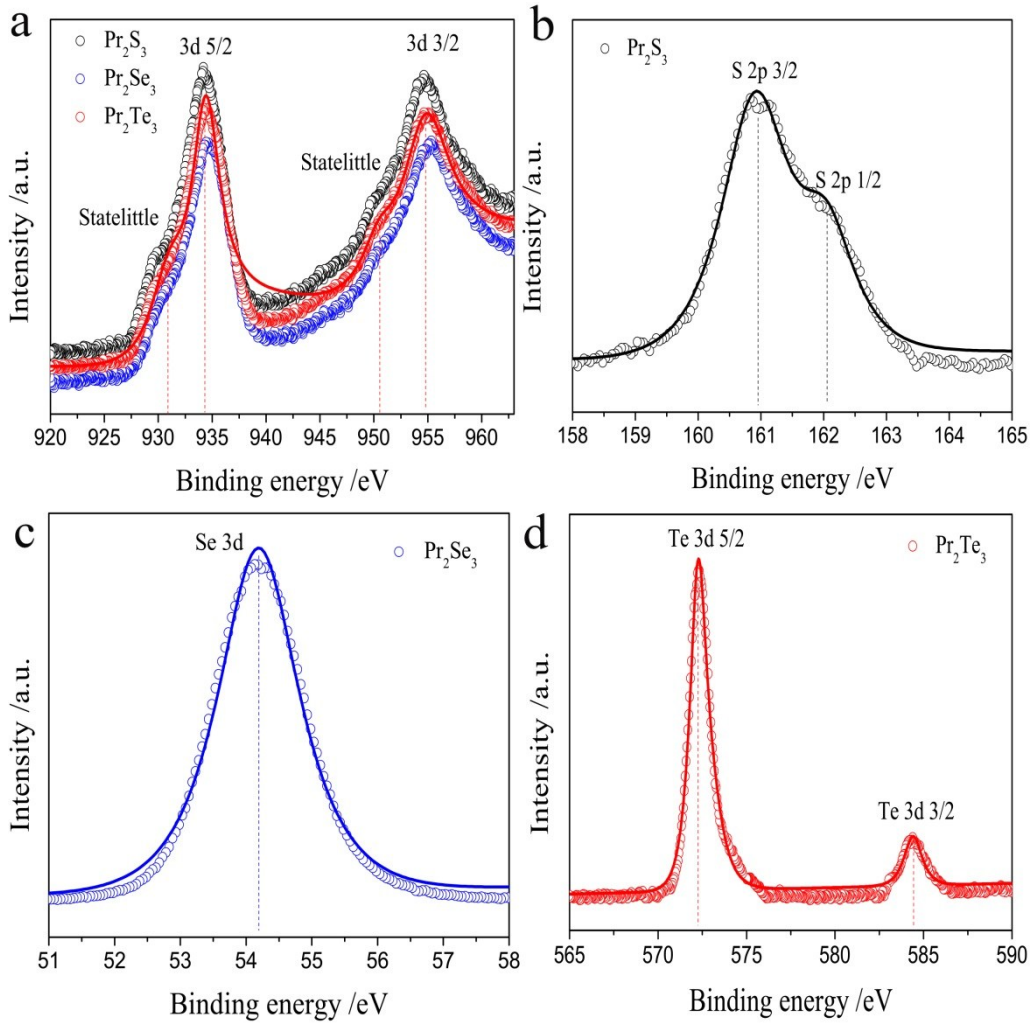


**Fig. S1** XPS spectra of Pr 3d for $Pr_2(S, Se, Te)_3$ QDs (a), XPS spectra of S 3d for $Pr_2S_3$ QDs (b), Se 3d for $Pr_2Se_3$ QDs (c) and Te 3d for $Pr_2Te_3$ QDs (d).

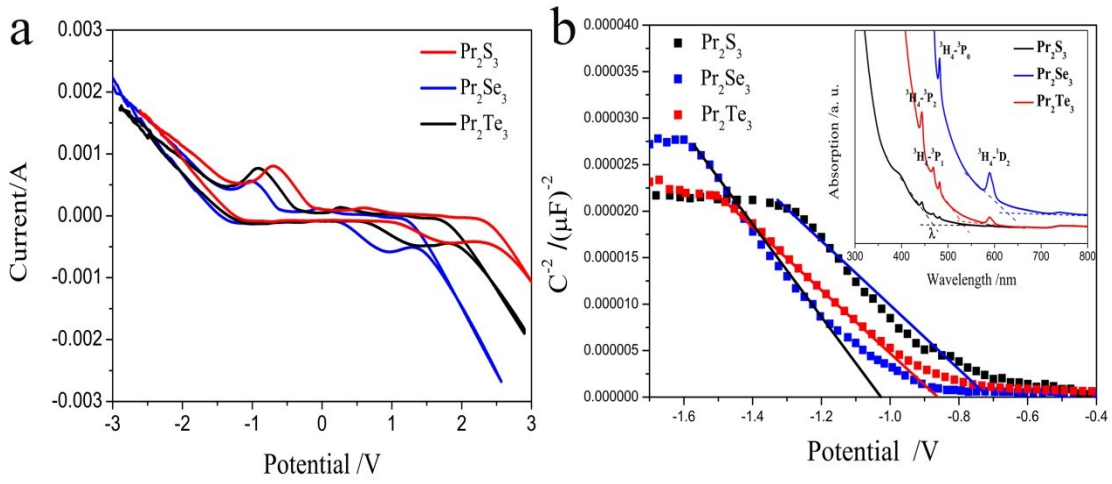


**Fig. S2** (a) The CV characteristics of the QD films in acetonitrile containing 0.1 M tetramethylammonium perchlorate in dimethylformamide at a sweep rate of 50 mV $s^{-1}$; (b) Mott-Schottky plots of the different QD films at 1 kHz in 0.05 M $Na_2SO_4$ aqueous solution and the insert highlights the UV-vis absorption spectra of the three films.

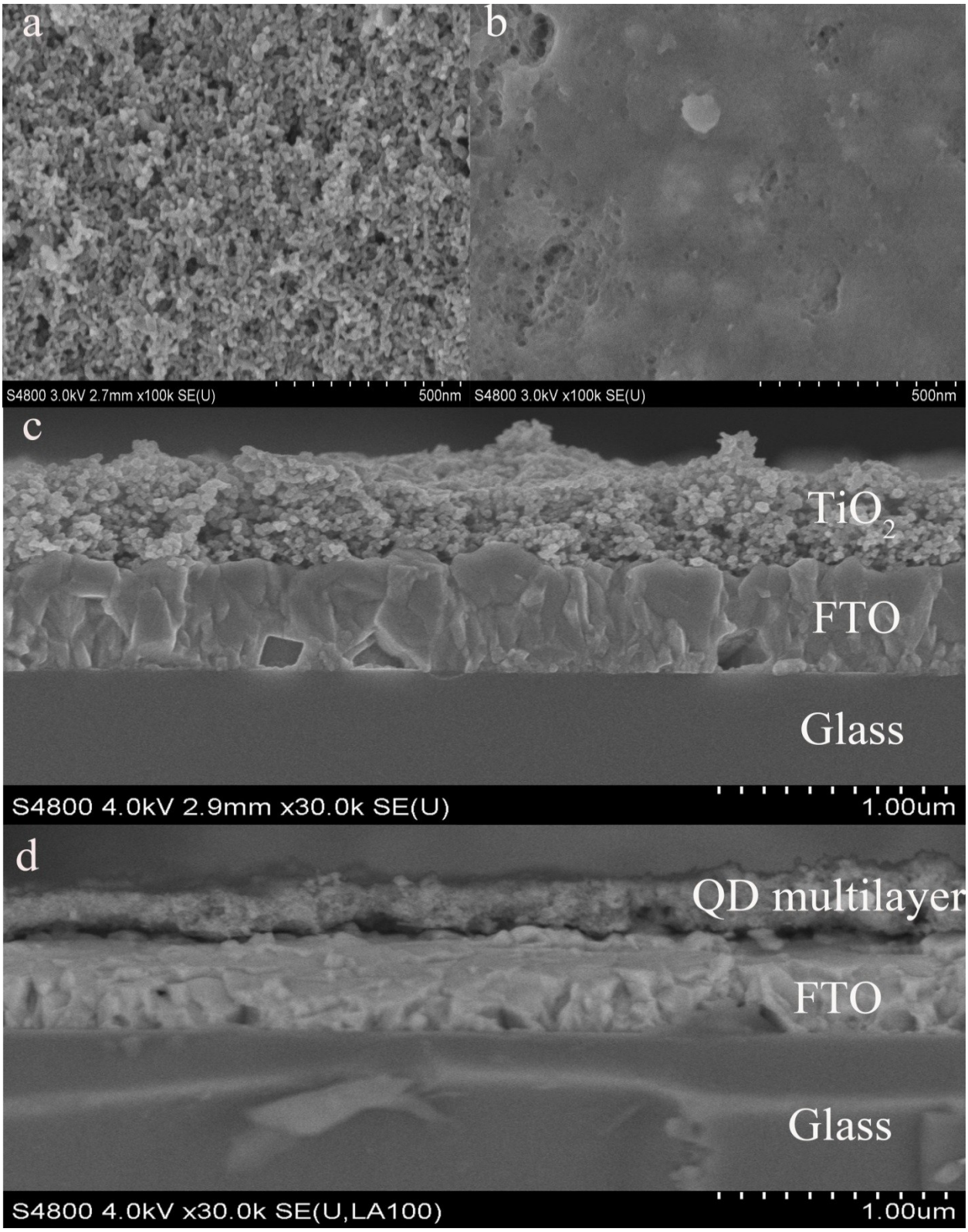


**Fig. S3** SEM images of the bare $TiO_2$ (a) and $Pr_2Se_3/Pr_2Te_3/Pr_2S_3/TiO_2$ films, cross-sectional SEM images of $TiO_2$ (c) and the QD multilayers (d).

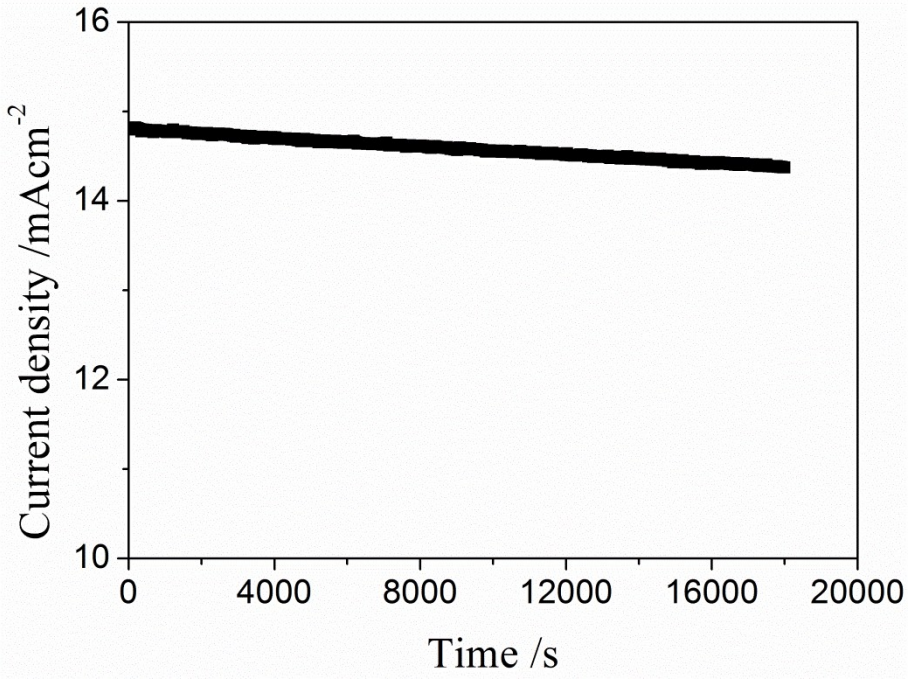


**Fig. S4**. Photocurrent density of the assembled $Pr_2Se_3/Pr_2Te_3/Pr_2S_3/TiO_2$ quadruple-stack QDSC was recorded with irradiation over 5 h under prolonged irradiation of 100 $mWcm^{-2}$.

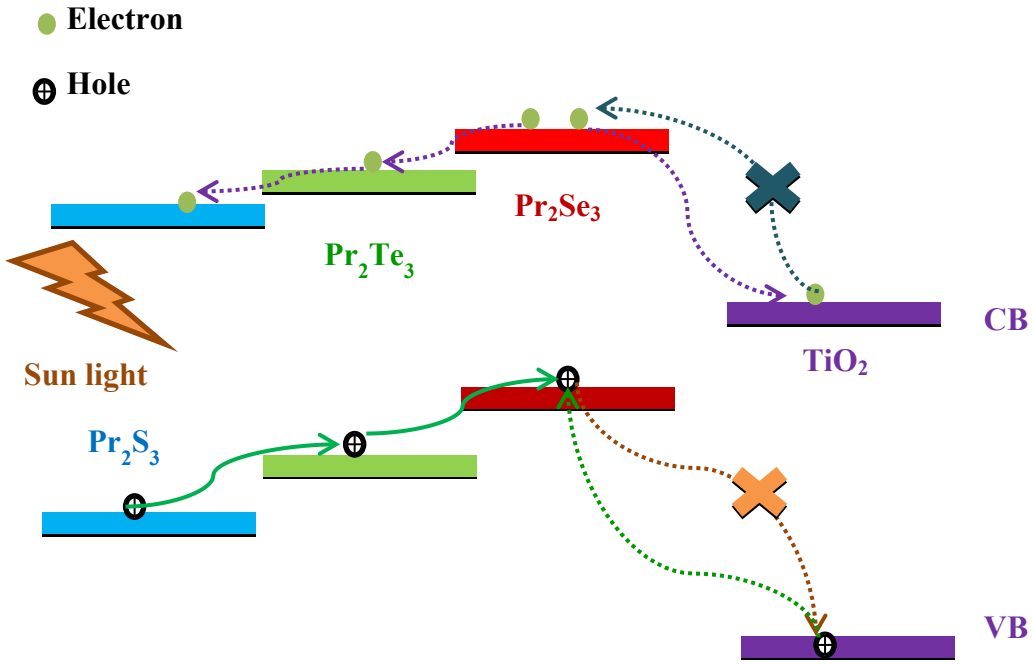


**Fig. S5**. Energy band diagram of the $Pr_2S_3/Pr_2Te_3/Pr_2Se_3/TiO_2$ heterojunction and the schematic diagram displaying charge transfer for photogeneration in the QDs.

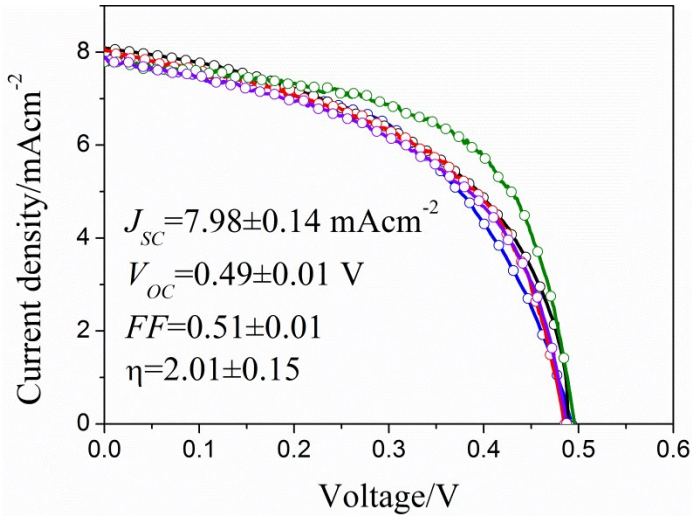


**Fig. S6**. *J–V* characteristics of $Pr_2S_3/Pr_2Te_3/Pr_2Se_3/TiO_2$ QDSC under AM1.5G solar simulated illumination.

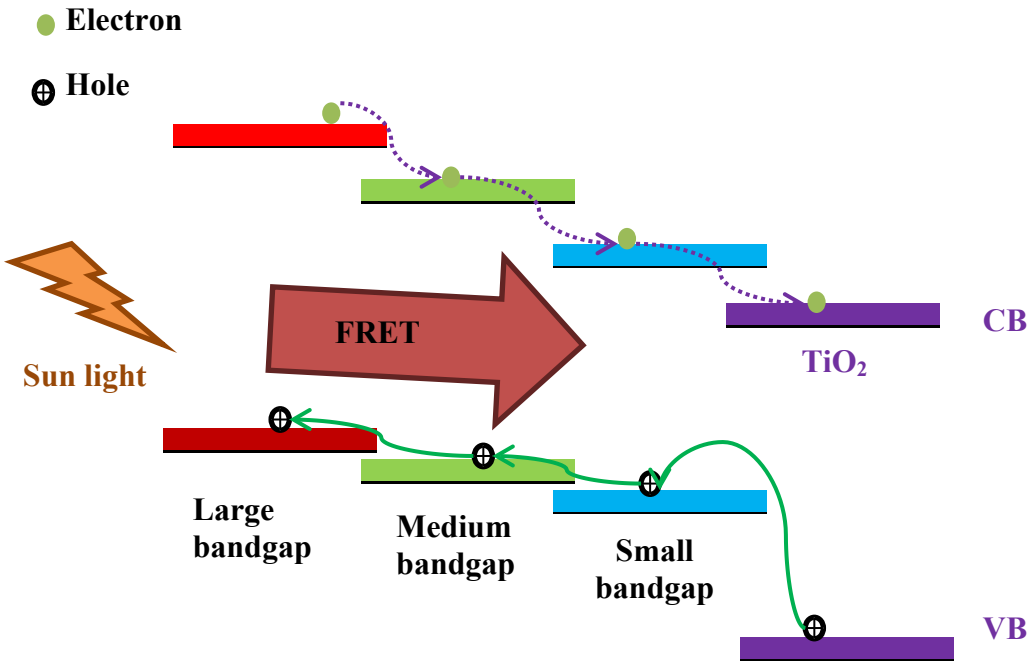


**Fig. S7**. The schematic diagram of an ideal multilayer displaying the energy levels, charge transfer, and FRET.

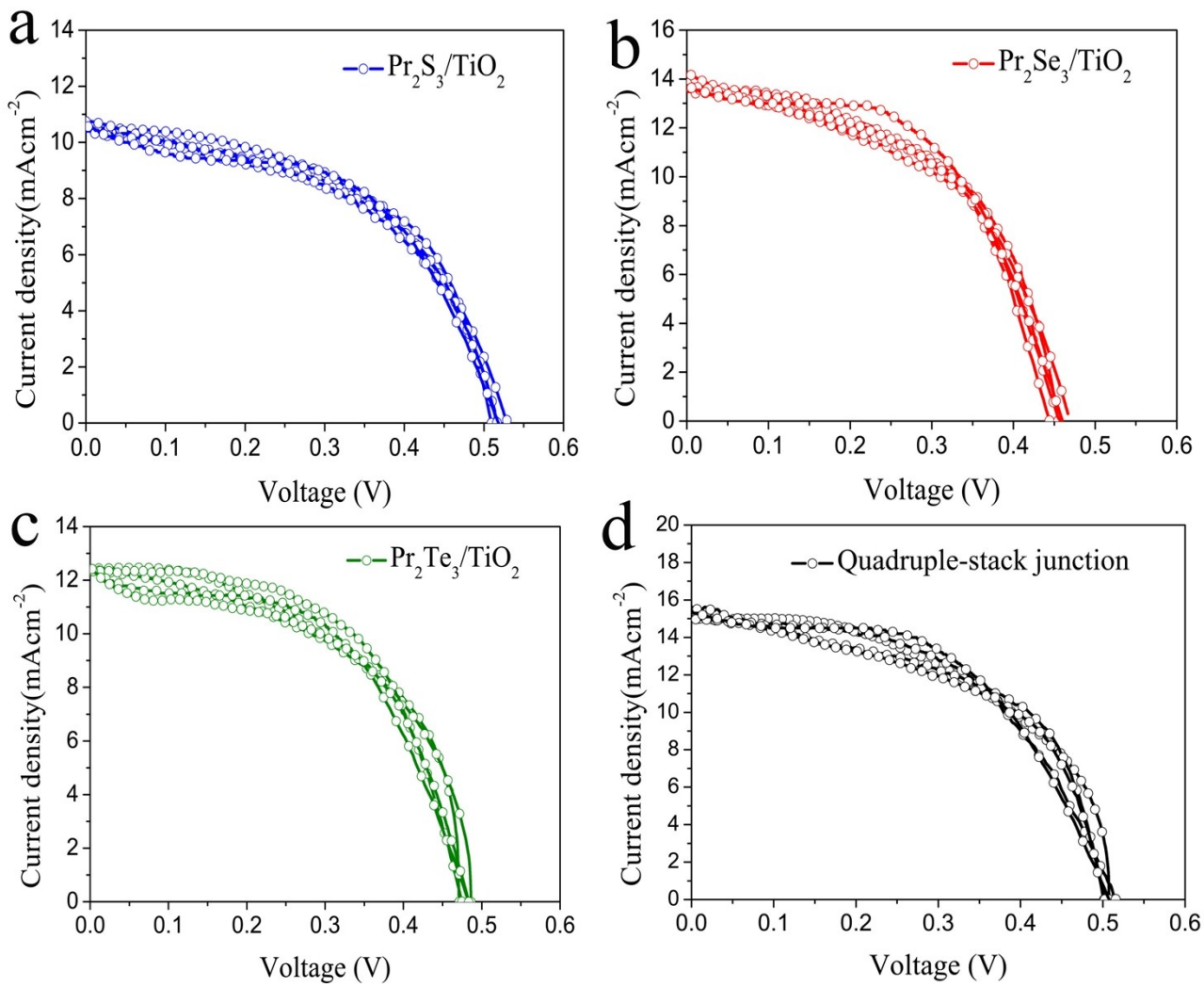


**Fig. S8**. *J–V* characteristics of $Pr_2S_3/TiO_2$ (a) $Pr_2Se_3/TiO_2$ (b) $Pr_2Te_3/TiO_2$ and $Pr_2Se_3/Pr_2Te_3/Pr_2S_3/TiO_2$ QDSCs in AM1.5G solar simulated light.