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Supplementary Materials

Black TiO_2-Based Dual Photoanodes Boost the Efficiency of Quantum Dot-Sensitized Solar Cells to 11.7%

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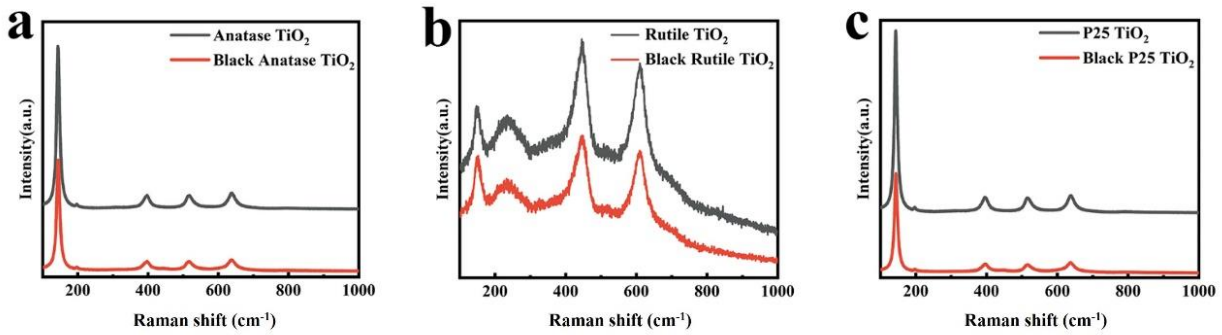

Figure S1. (**a**) Raman spectra of anatase TiO_2 and black anatase TiO_2. (**b**) Raman spectra of rutile TiO_2 and black rutile TiO_2. (**c**) Raman spectra of P25 TiO_2 and black P25 TiO_2.

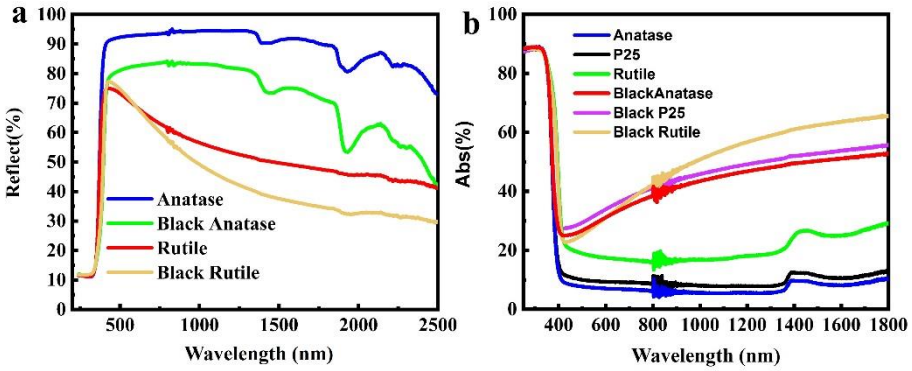

Figure S2. (**a**) Diffuse reflectance spectra of anatase, rutile, P25, black anatase, black rutile, black P25 nanoparticles. (**b**) Diffuse absorb spectra of anatase, rutile, P25, black anatase, black rutile, black P25 nanoparticles.

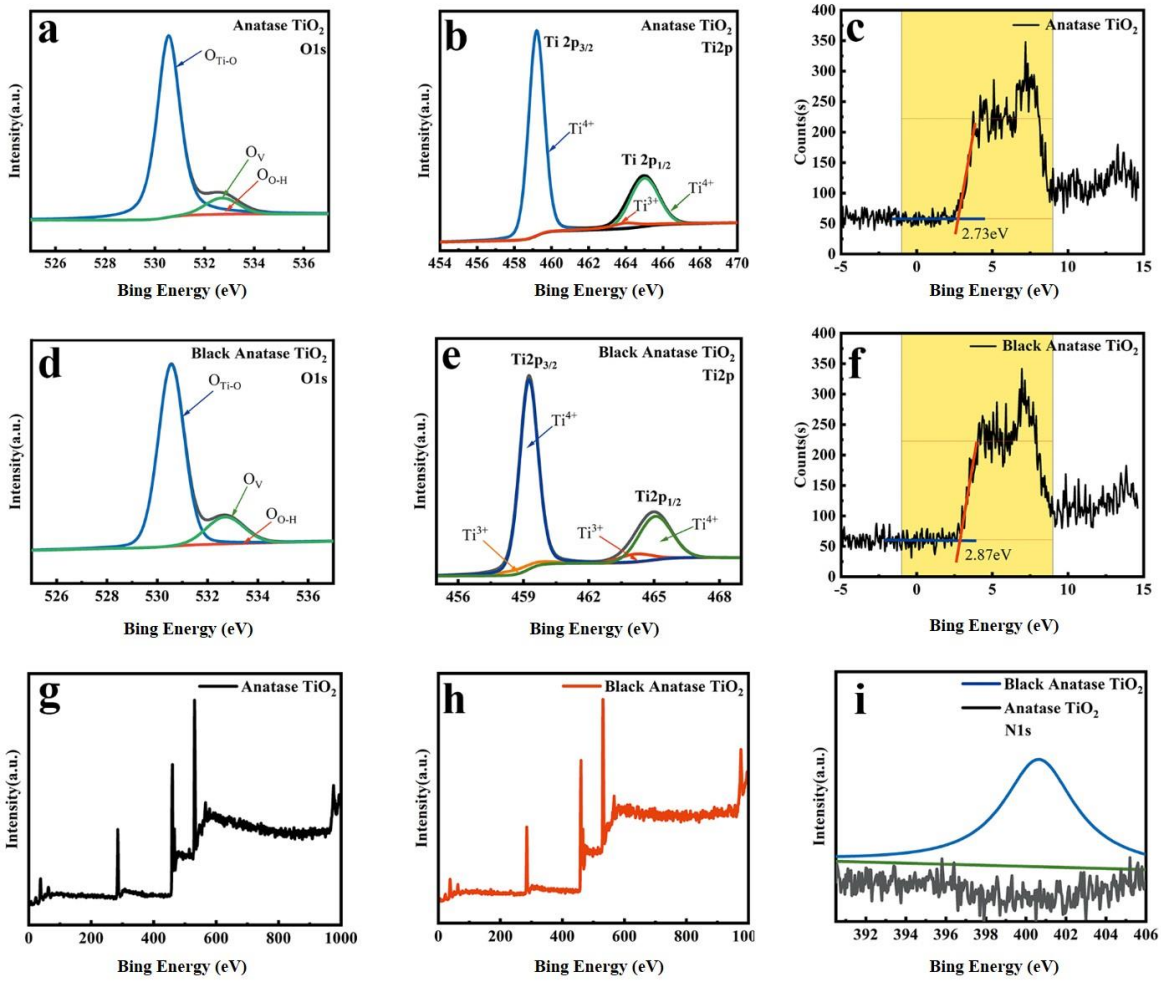

Figure S3. (**a**) O1s XPS spectrum of anatase TiO_2. (**b**) Ti2p XPS spectrum of anatase TiO_2. (**c**) UPS spectrum of anatase TiO_2. (**d**) O1s XPS spectrum of black anatase TiO_2. (**e**) Ti2p XPS spectrum of black anatase TiO_2. (**f**) UPS spectrum of black anatase TiO_2. (**g**) XPS survey of anatase TiO_2. (**h**) XPS survey of black anatase TiO_2. (**i**) N1s XPS spectra of anatase TiO_2 and black anatase TiO_2. The green line is the baseline of the curve.

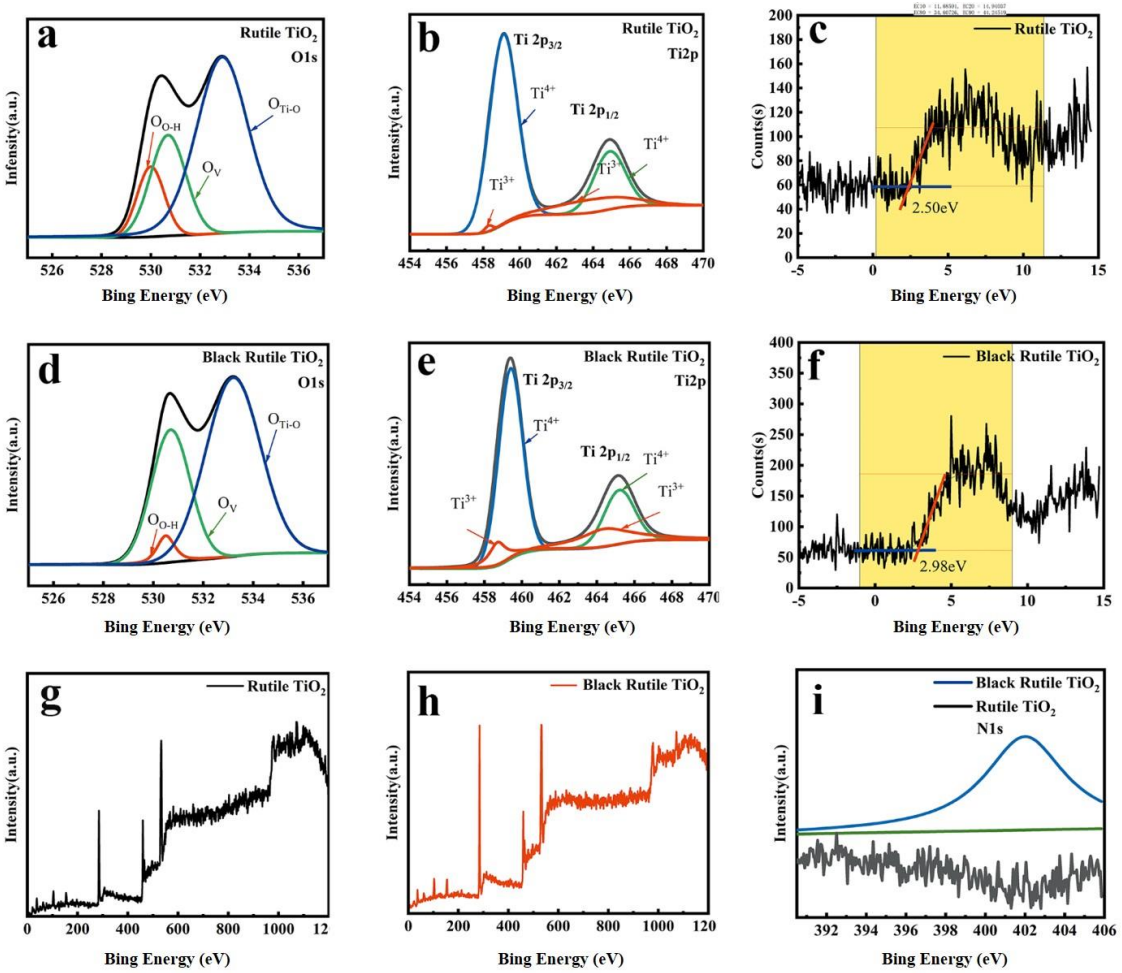

Figure S4. (**a**) O1s XPS spectrum of rutile TiO_2. (**b**) Ti2p XPS spectrum of rutile TiO_2. (**c**) UPS spectrum of rutile TiO_2. (**d**) O1s XPS spectrum of black rutile TiO_2. (**e**) Ti2p XPS spectrum of black rutile TiO_2. (**f**) UPS spectrum of black rutile TiO_2. (**g**) XPS survey of rutile TiO_2. (**h**) XPS survey of black rutile TiO_2. (**i**) N1s XPS spectrum of rutile TiO_2 and black rutile TiO_2. The green line is the baseline of the curve.

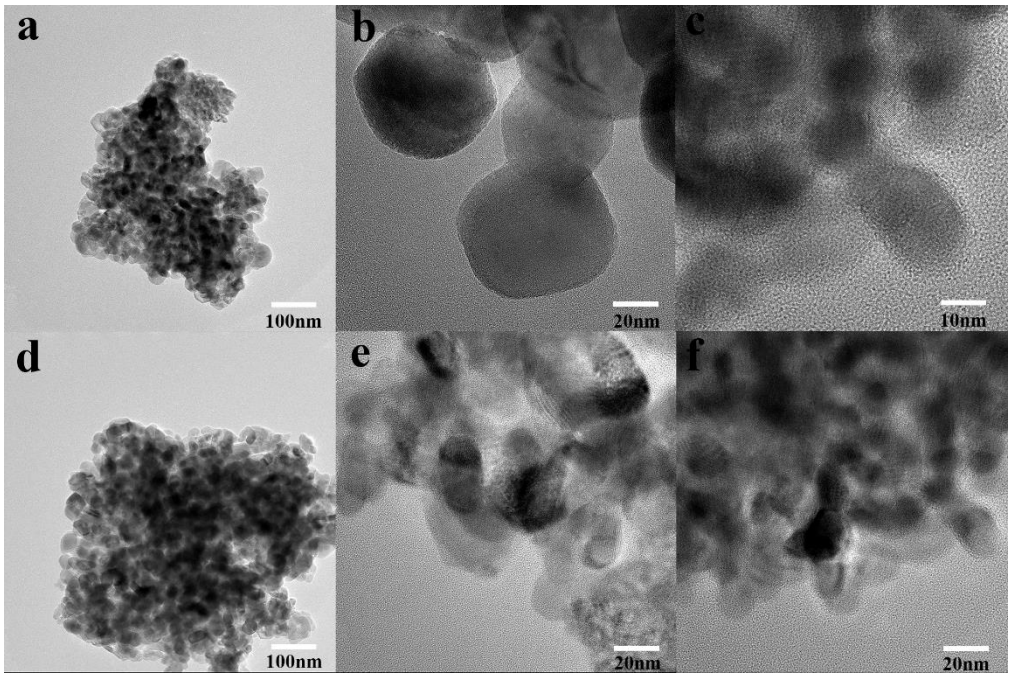

Figure S5. TEM and HRTEM images of anatase TiO_2 with different magnifications (**a**-**f**).

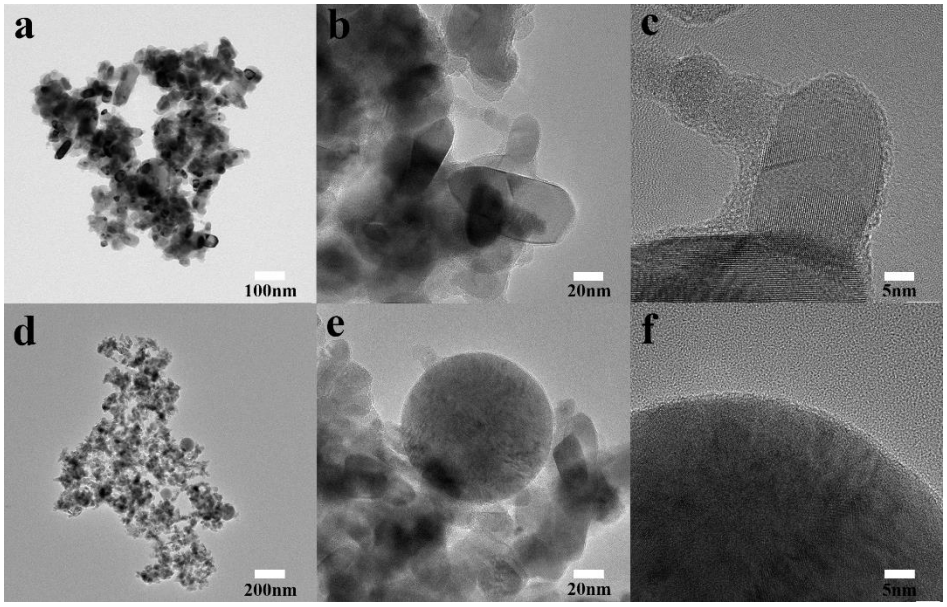

Figure S6. TEM and HRTEM images of black anatase TiO_2 with different magnifications (**a**-**f**).

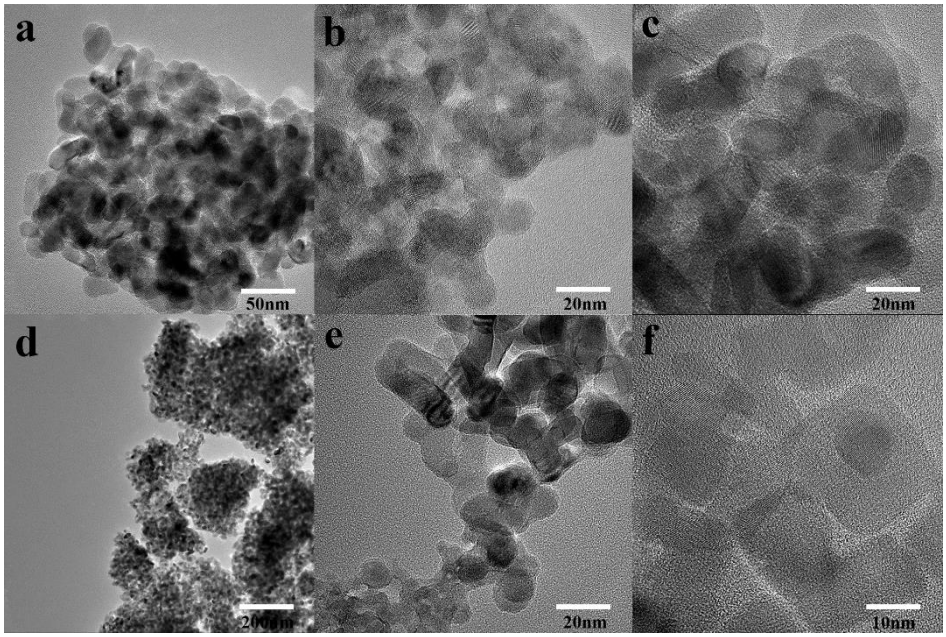

Figure S7. TEM and HRTEM images of rutile TiO_2 with different magnifications (**a**-**f**).

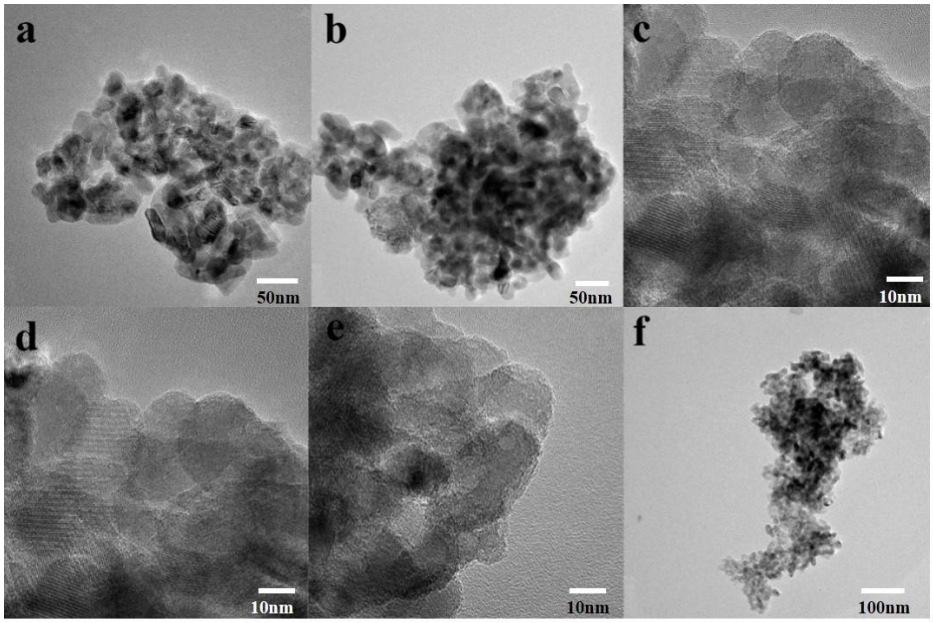

Figure S8. TEM and HRTEM images of black rutile TiO_2 with different magnifications (**a**-**f**).

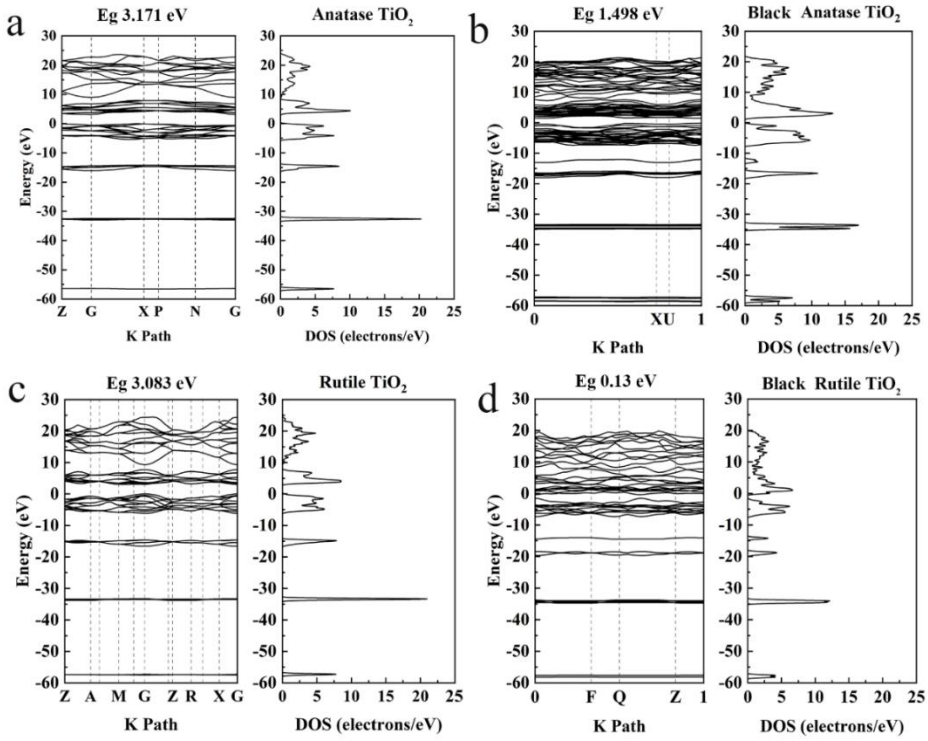

Figure S9. Energy band diagram and density of states spectrum obtained by first-principles calculations for (a) anatase TiO_2, (b) black anatase TiO_2, (c) rutile TiO_2, and (d) black rutile TiO_2.

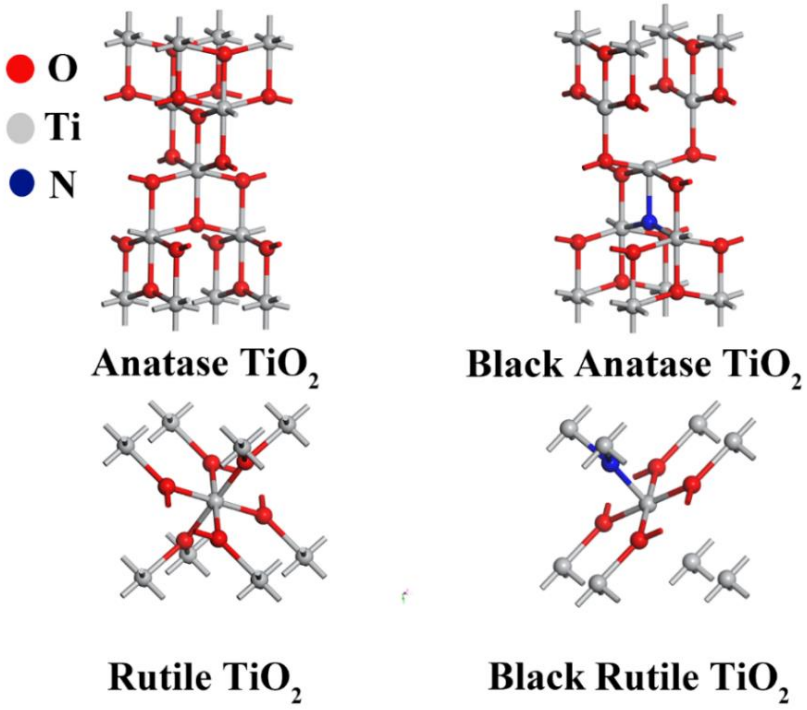

Figure S10. Unit cells of anatase TiO_2, black anatase TiO_2, rutile TiO_2, and black rutile TiO_2 for first-principles calculations.

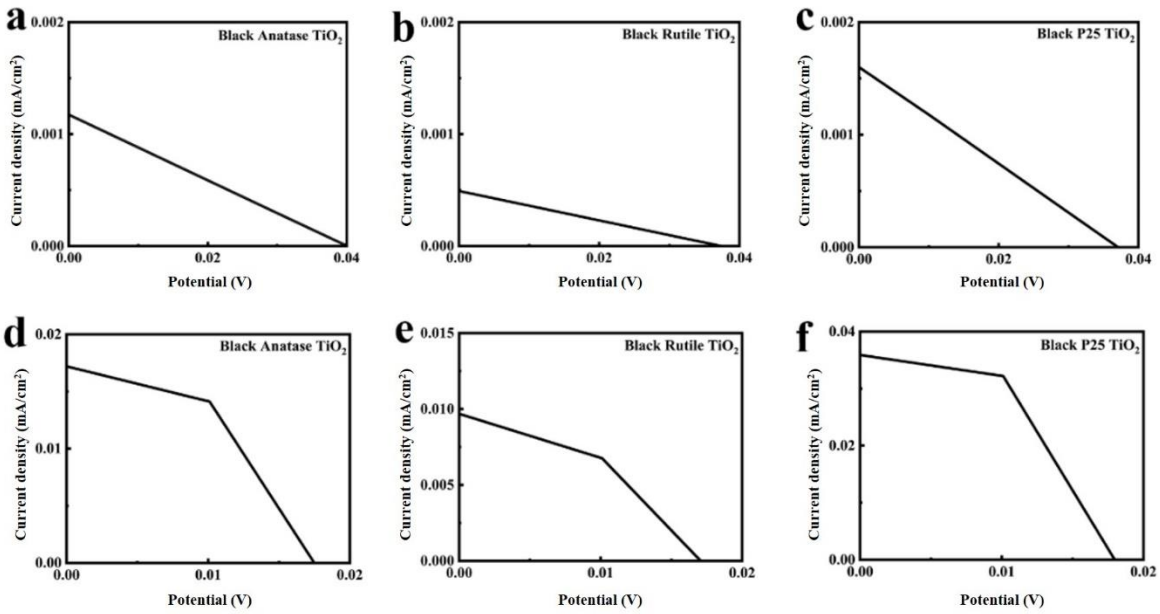

Figure S11. (**a**), (**b**) and (**c**) are J-V curves of black anatase TiO_2, rutile TiO_2, and P25 TiO_2 samples assembled with a S^{2-}/Sn^{2-} electrolyte and copper sulfide counter electrode without quantum dot sensitization. (**d**), (**e**) and (**f**) are J-V curves of black anatase TiO_2, rutile TiO_2, and P25 TiO_2 samples assembled with a platinum electrode using S^{2-}/Sn^{2-} electrolyte without quantum dot sensitization.

Table S1. Performance parameters of CdS/CdSe co-sensitized QDSSCs based on different reports.

Photoanode	QDs	J_{sc}(mA/cm^2)	V_{oc}(V)	FF	PCE(%)	Ref.
TiO_2 NPs	CdS/CdSe	11.91	0.59	0.51	3.56	S1
ZnO NDs/TiO_2 NPs	CdS/CdSe	15.34	0.66	0.53	5.36	S2
TiO_2 NWs–ZnO NSs	CdS/CdSe	16.11	0.51	0.55	4.57	S3
TiO_2 NWsTiO_2 NSs–ZnO NRs	CdS/CdSe	19.19	0.52	0.54	5.38	S4
TiO_2 MPsNWs	CdS/CdSe	19.32	0.53	0.59	6.01	S5
TiO_2 NWs	CdS/CdSe	17.98	0.47	0.50	4.20	S6
ZnO NDs	CdS/CdSe	16.0	0.62	0.49	4.86	S7
ZnO TP	CdS/CdSe	13.85	0.72	0.42	4.24	S8
ZnO NWs	CdS/CdSe	17.3	0.63	0.38	4.15	S9
TiO_2/ZnO NSs	CdS/CdSe	16.11	0.51	0.55	4.57	S10
black P25 TiO_2 NDs	CdS/CdSe	25.0	0.61	0.38	5.91	**This work**
D-G black P25 TiO_2 NDs	CdS/CdSe	50.**3**	0.61	0.39	11.67	**This work**

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