Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supplementary Material

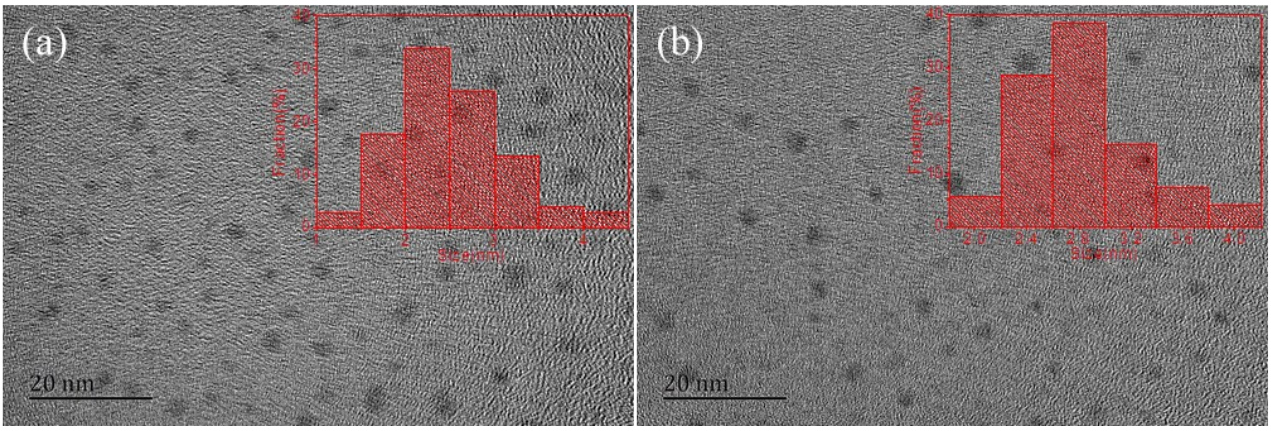

Fig. S1 TEM morphologies of (a) CQD-C(8.64) and (b) CQD-C(11.79)

(Insets: particle size distributions)

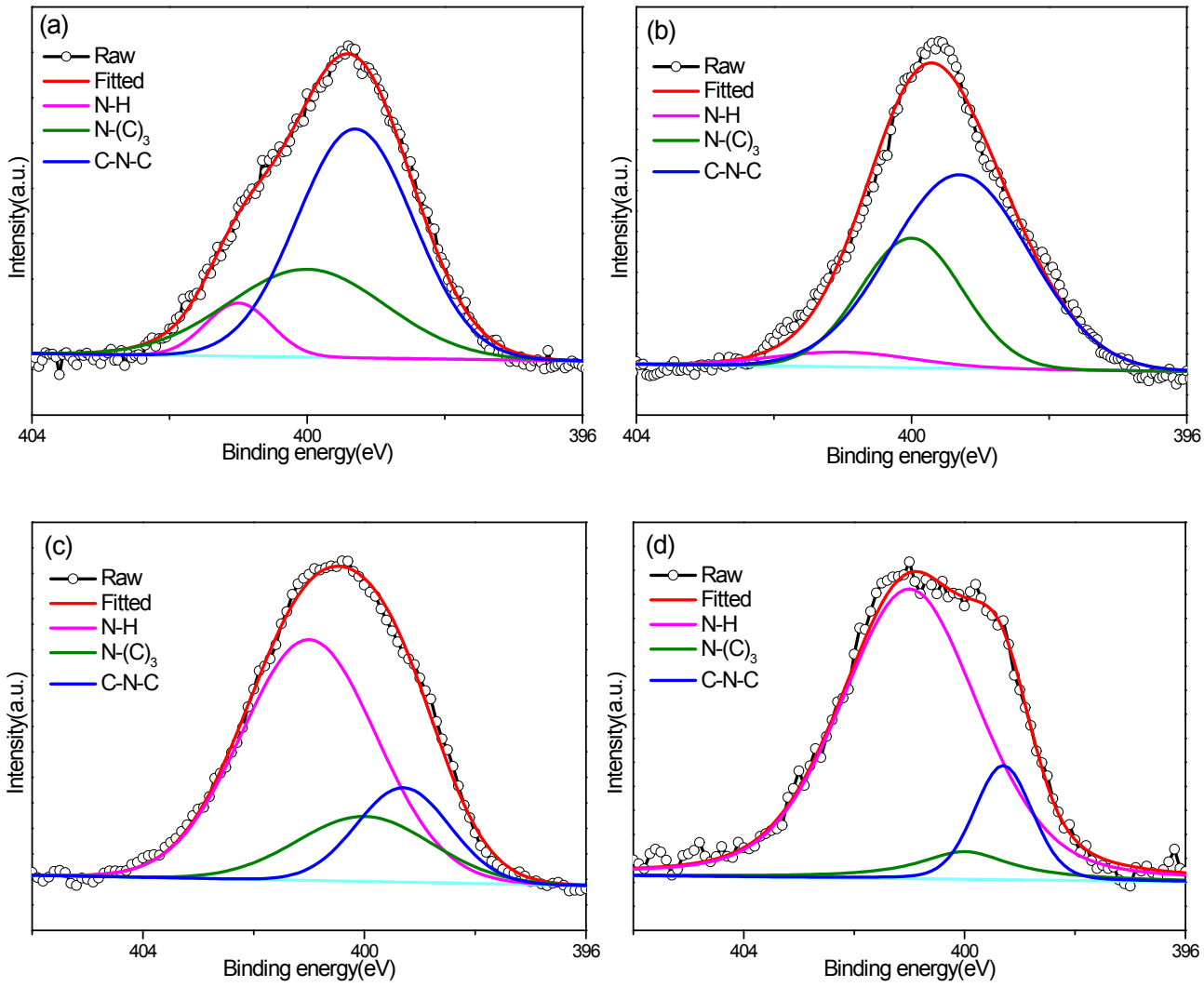

Fig. S2 XPS high-resolution scans in N 1s of (a) CQD-C, (b) CQD-T, (c) CQD-D and (d) CQD-N

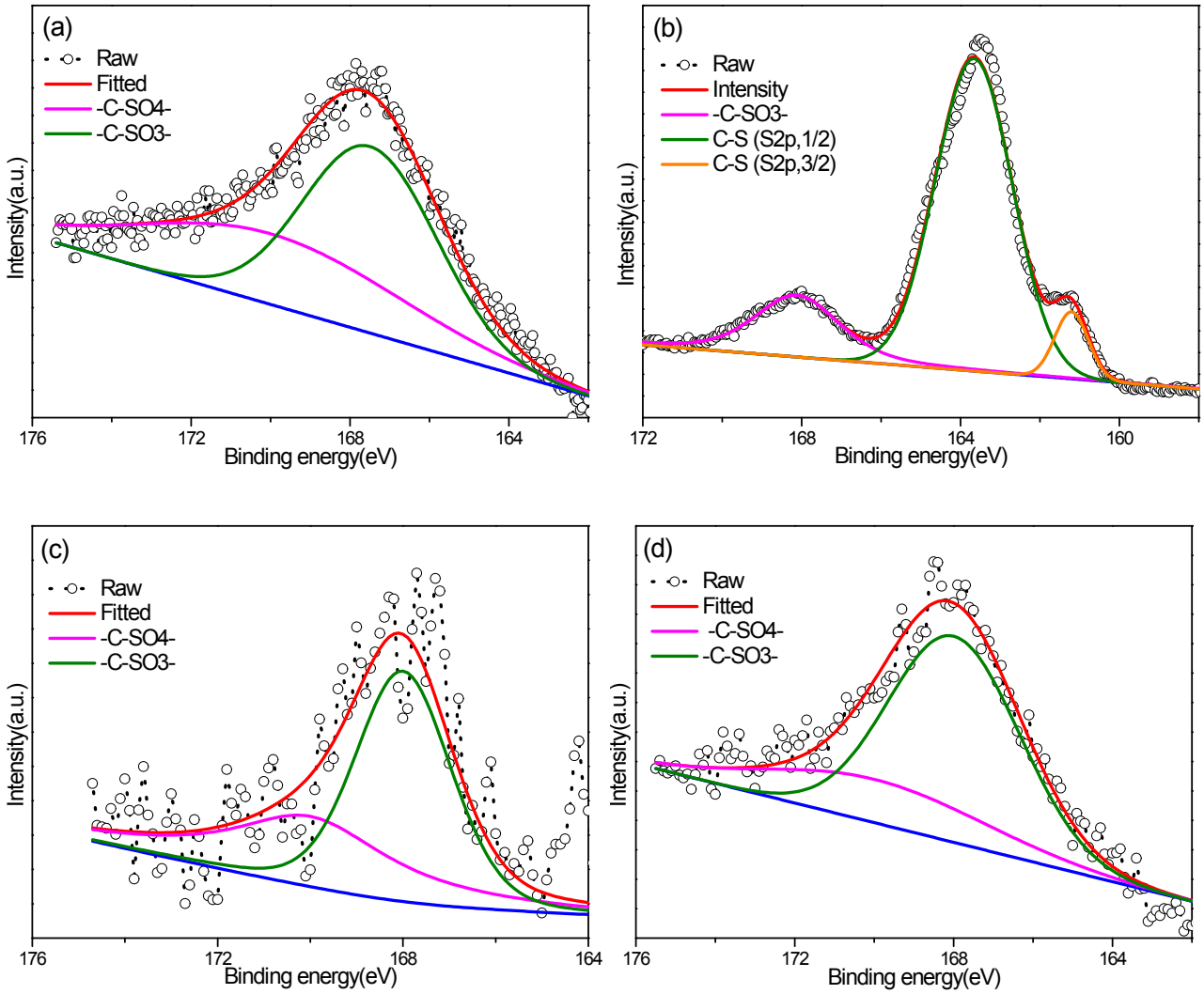

Fig. S3 XPS high-resolution scans in S 2p of (a) CQD-C, (b) CQD-T, (c) CQD-D and (d) CQD-N

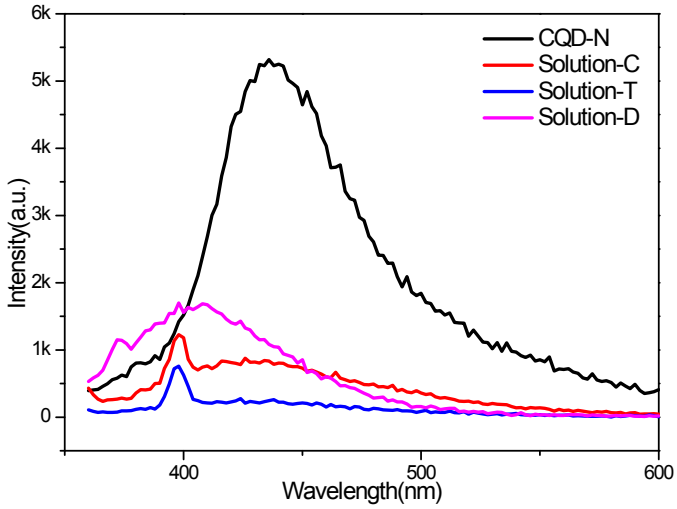

Fig. S4 Emission spectra of four CQD solutions at maximum excitation wavelength

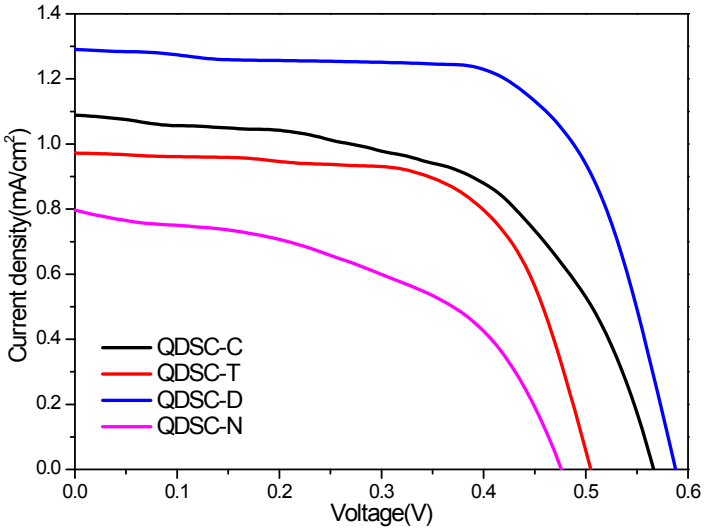

Fig. S5 J-V characteristics of QDSCs

Table S1 Photovoltaic parameters of QDSC with different dopants

Sample	Dopant	J_{sc}(mA cm^{-2})	V_{oc}(V)	FF	PCE(%)
QDSC-C	Carbamide	1.09	0.57	0.57	0.352
QDSC-T	Thiourea	0.97	0.51	0.65	0.322
QDSC-D	1,3-Diaminopropane	1.29	0.59	0.67	0.510
QDSC-N	None	0.80	0.48	0.49	0.187

Table S2 Photoelectric properties of representative biomass CQD-based QDSC

Carbon source	Dopant	J_{sc}(mA/cm^2)	V_{oc}(V)	FF	PCE(%)	Reference
Chitin+chitosan	None	0.67	0.27	0.43	0.08	Briscoe[73]
Bee pollen	None	0.33	0.46	0.73	0.11	Guo[74]
Eichhornia crassipes	None	0.48	0.53	0.67	0.17	Yang[75]
Absorbent cotton	1,3-Diaminopropane	1.28	0.57	0.72	0.53	This paper

Table S3 Energy levels of CQDs

CQD	LUMO(eV)	HOMO(eV)	Band gap(eV)
CQD-C	-3.81	-5.06	1.25
CQD-T	-3.89	-5.18	1.29
CQD-D	-3.91	-5.09	1.18
CQD-N	-3.85	-5.15	1.30

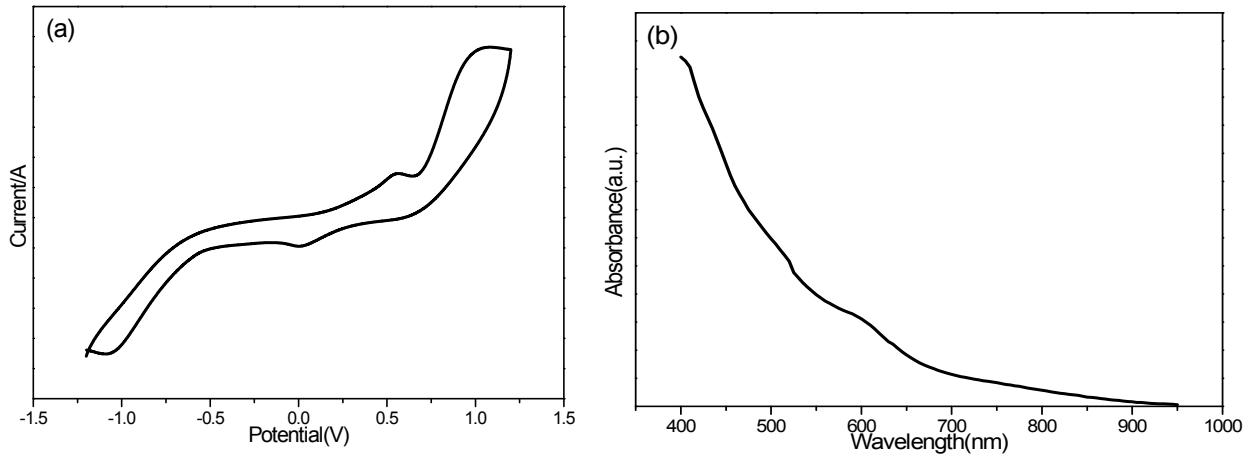

Fig. S6 (a) CV curve and (b) UV-Vis diffuse reflectance absorption spectrum of CQD-N

The CV method is used to detect the band gap connected to the excited ability of semiconductor, and the CV curve of the undoped CQD measured in a solution sample with acetonitrile as the solvent is shown in Fig. S6(a). The onset-potentials of the oxidation and reduction peaks related to electron and hole injection into the conduction and valence bands are about 0.7 V and -0.6 V respectively. Thus, the band gap of the undoped CQD is 1.3 eV. The optical band gap energy was also acquired from UV-Vis diffuse reflectance absorption spectrum shown in Fig. S6(b), and the absorption edge was about 950 nm. Therefore the band gap is 1.3 eV, according to the equation: $E_g = 1240 / \lambda_{abs}$. The results obtained by these two methods are consistent. Mirtchev et al. [1] synthesized undoped CQD with the size of 20-30 nm through dehydration of λ-butyrolactone, whose band gap was approximately 1.1 eV.

[1] Mirtchev P, Henderson E J, Soheilnia N, et al. Solution phase synthesis of carbon quantum dots as sensitizers for nanocrystalline TiO 2 solar cells[J]. Journal of Materials Chemistry, 2012, 22(4): 1265-1269.