Electronic Supplementary Information

Carbon dot-based white and yellow electroluminescent light emitting diodes with a record-breaking brightness

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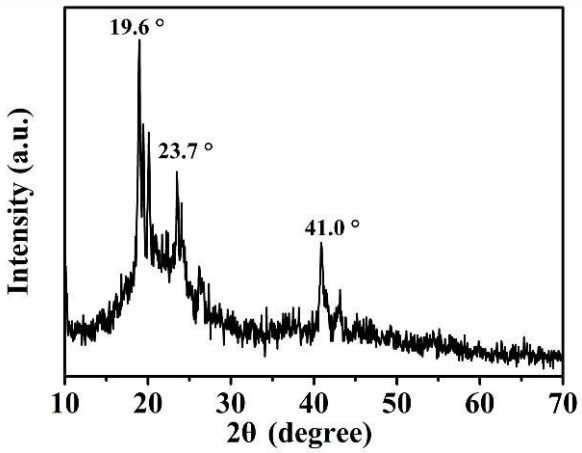

Fig. S1 XRD patterns of CDs.

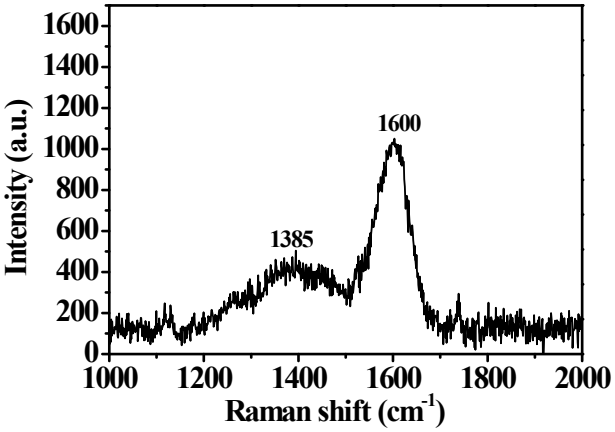

Fig. S2 Raman spectrum of CDs.

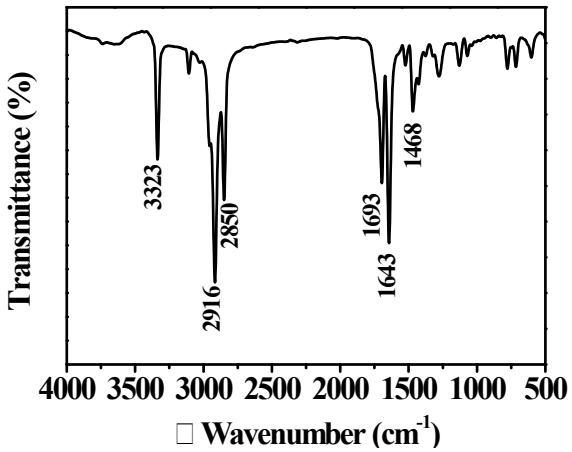

Fig. S3 FT-IR spectrum of CDs.

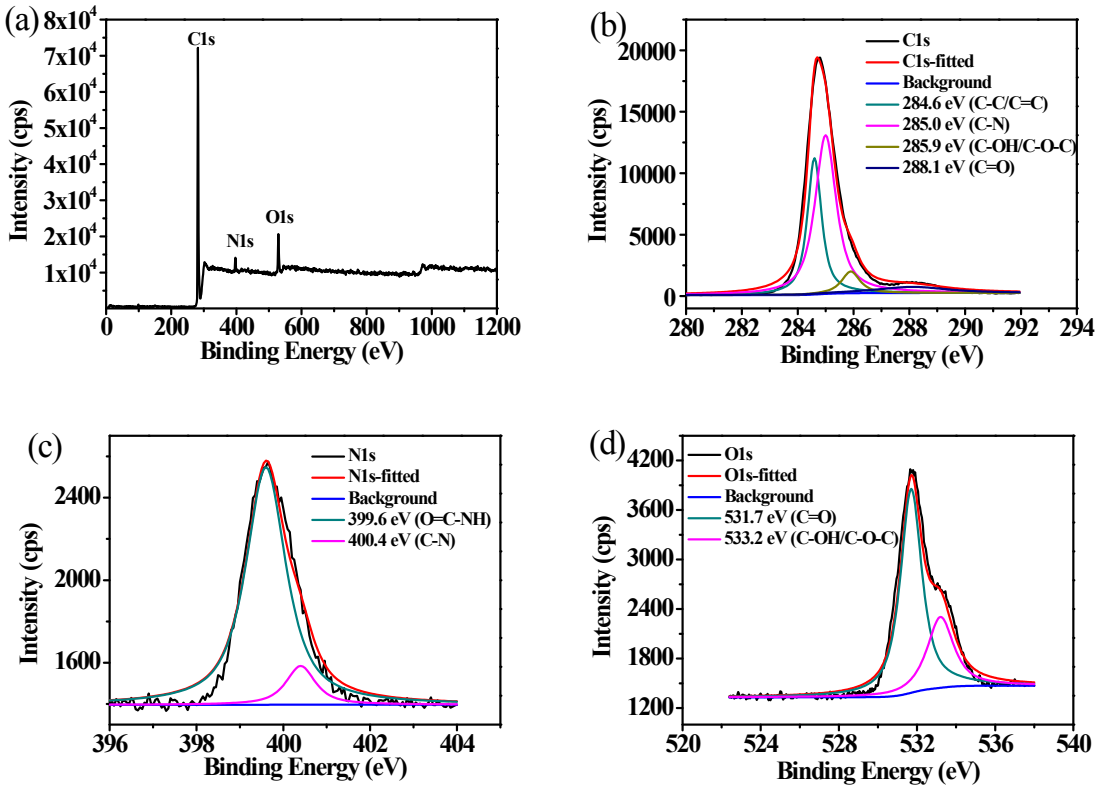

Fig. S4 (a) XPS spectra and corresponding high resolution spectra of (b) C1s. (c) N1s and (d) O1s peaks of CDs.

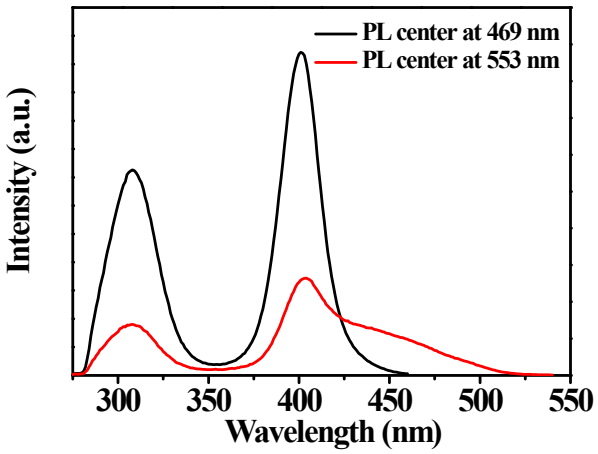

Fig. S5 Excitation spectra of CD solution at emission of 469 and 553 nm.

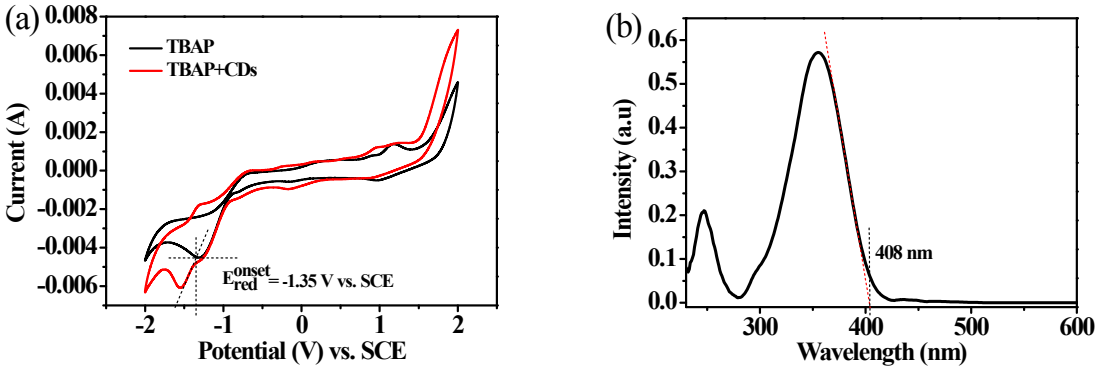

Fig. S6 (a) CV curves of CDs in TBAP solution (0.1 mol L^{-1}, CH_2Cl_2).

(b) UV-vis spectra of CDs.

Note: CV curves and UV-vis absorption of CDs were obtained to calculate the highest occupied molecular orbital (HOMO) and the lowest unoccupied molecular orbital (LUMO) energy levels of CDs. As shown in Fig. S3(a), the onset reduction potential of CDs is obtained as –1.35 V vs. SCE, without obvious oxidation peak. According to Equation (1), the E_{LUMO} of CDs is –3.39 eV. The λ_{onset} is determined to be 408 nm from the UV-vis absorption spectra of CDs (Fig. S3(b)), and according to Equation (2), the energy gap of CDs is then calculated to be E_g = 3.04 eV. According to Equation (3), the E_{HOMO} value of –6.43 eV is obtained for CDs.

$$E_{LUMO} = -e\,(E_{red}^{onset} + 4.74) \quad (1)$$

$$E_g = 1240/\lambda_{onset} \quad (2)$$

$$E_{HOMO} = E_{LUMO} - E_g \quad (3)$$

where E_{red}^{onset} is the onset reduction potential, λ_{onset} is onset absorption wavelength of UV-vis absorption. E_g is the energy gap of CDs.

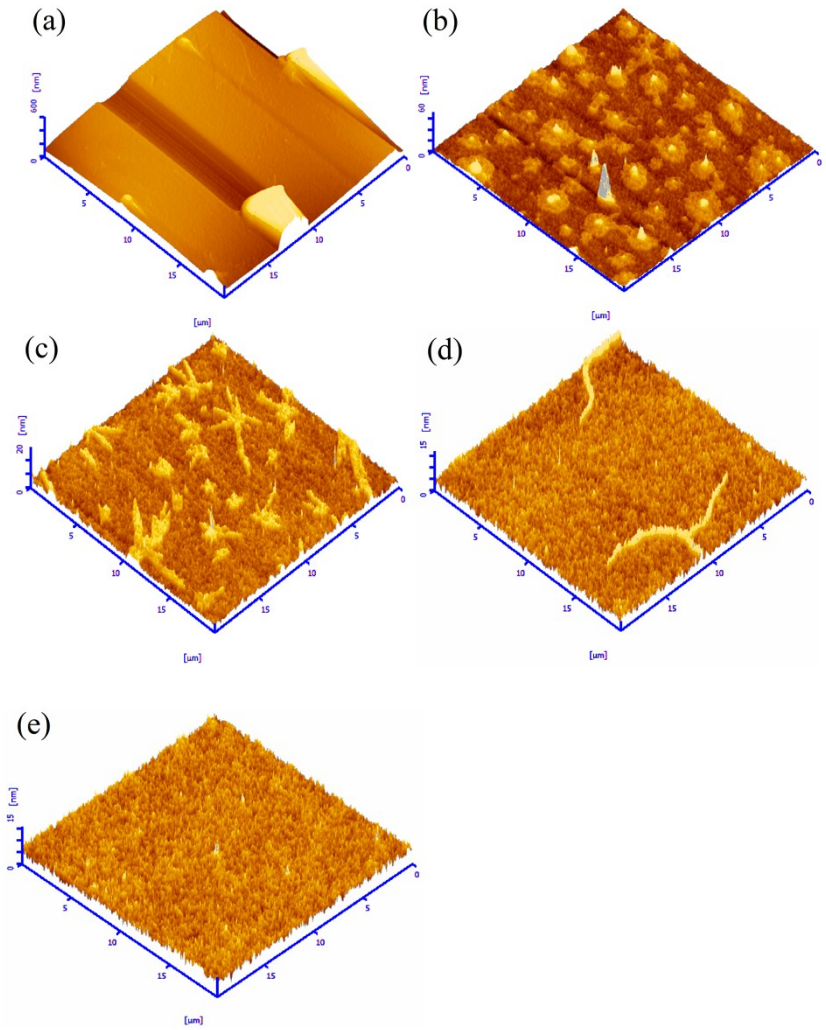

Fig. S7 AFM image of CD films spin-coated at different concentrations on PEDOT:PSS thin film (50 nm): (a) 5 mg/mL. (b) 1 mg/mL. (c) 0.5 mg/mL. (d) 0.1 mg/mL. (e) 50 nm-thick PEDOT:PSS surface.

Table S1 CD-LEDs performance at different concentrations of CDs

Concentration (mg/mL)	The brightness at 10 V (cd/m^2)
5	0
1	2.2
0.5	5.7
0.1	1.7

Table S2 Performances of doped CD-LEDs with different doping concentrations

Concentration (wt%)	Turn-on voltage (V)	L_{max} (cd/m^2)	Operating voltage (V)	CIE coordinates
0	5	295.9	11.0	(0.25, 0.25)
1	5	407.3	10.5	(0.24, 0.25)
5	6	448.6	11.0	(0.24, 0.24)
20	7	450.4	10.5	(0.25, 0.24)
25	7.5	835.8	11.5	(0.26, 0.28)
30	7.5	761.6	11.5	(0.27, 0.30)
35	7	455.2	11.5	(0.29, 0.33)
40	--	0.05	11.5	--

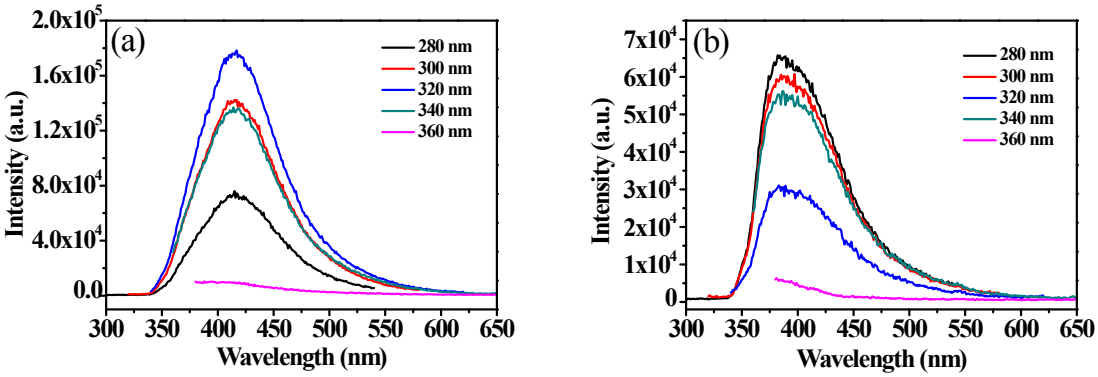

Fig. S8 (a) The PL spectra of PVK:TPBi (1:1 w/w) film (38 nm) under different excitation wavelengths. (b) The PL spectra of PVK:TmPyPB (1:1 w/w) film (38 nm) under different excitation wavelengths.

Table S3 The performance of white CD-LEDs with different thicknesses of emitting layer

Thickness (nm)	Turn-on voltage (V)	L_{max} (cd/m^2)	Operating voltage (V)	CIE coordinates	CRI	CCT (K)
38	7.0	455.2	11.5	(0.29, 0.33)	83	7694
27	6.0	467.3	10.5	(0.31, 0.36)	78	6430
19	5.5	473.5	9.5	(0.34, 0.41)	67	5259
15	5.0	548.9	7.5	(0.35, 0.42)	65	5072
10	4.5	432.2	7.5	(0.35, 0.43)	60	4985

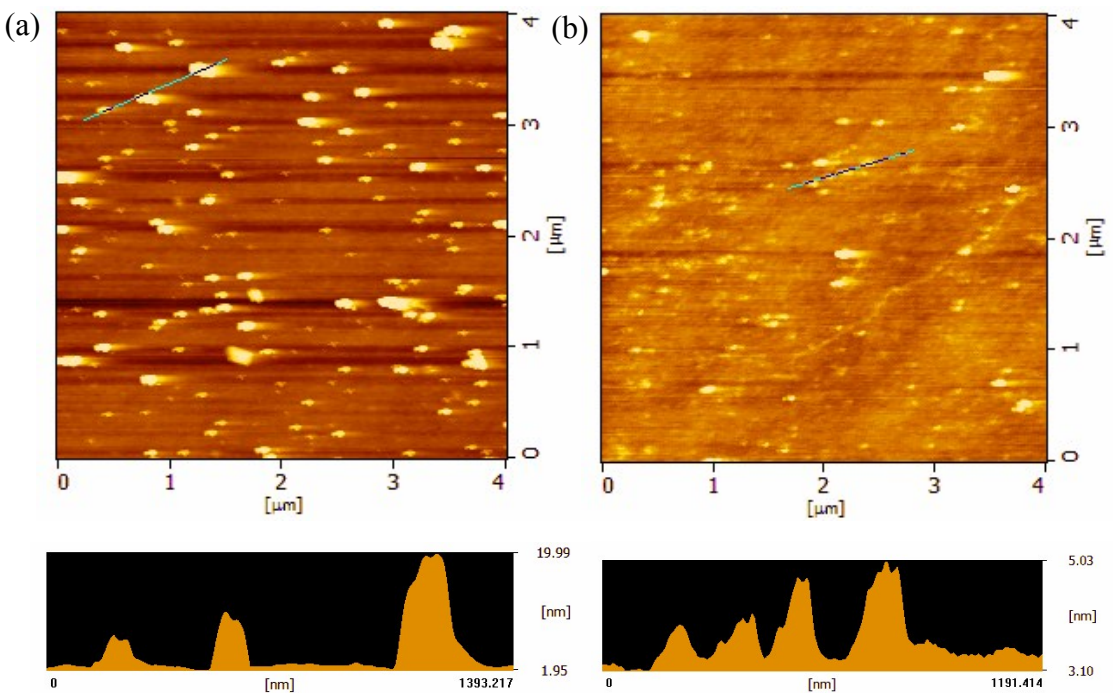

Fig. S9 AFM images and corresponding height profiles of (a) CDs, (b) PVK:CD composites.

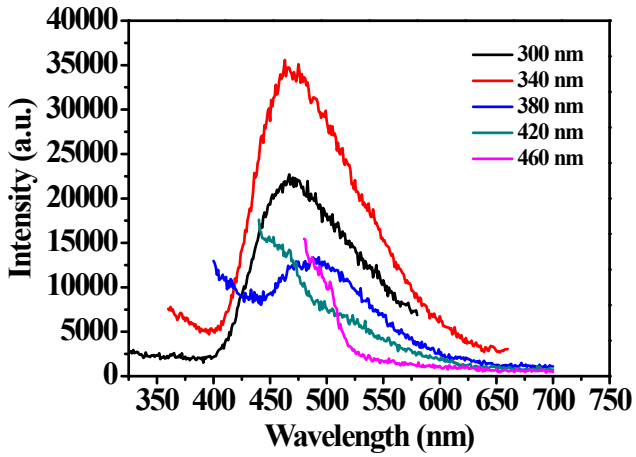

Fig. S10 The PL spectra of PVK:CD film (65:35 w/w) under different excitation wavelengths.

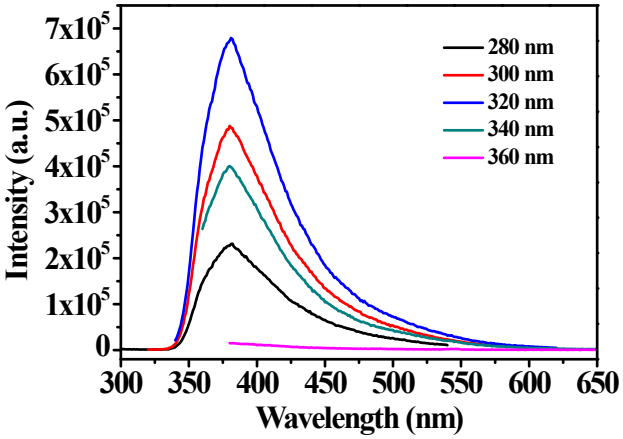

Fig. S11 The PL spectra of TPBi film under different excitation wavelengths.