

Electronic Supplementary Information (ESI)

Materials and Instruments

All the chemicals and reagents are purchased from commercial sources and used as received with vacuum sublimation purification. UV-vis absorption spectra are measured on a Shimadzu UV-2600 spectrophotometer. PL spectra are recorded on a Horiba Fluoromax-4 spectrofluorometer. PL quantum yields are measured using a Hamamatsu absolute PL quantum yield spectrometer C11347 Quantaaurus_QY. Transient PL decay spectra are measured under vacuum atmosphere for the films, using FLS-1000 fluorescence lifetime measurement system. Cyclic voltammogram is performed in dichloromethane or dimethylformamide containing 0.1 M tetrabutylammonium hexafluorophosphate with the scan rate of 50 mV s⁻¹, using a platinum wire as the auxiliary electrode, a glass carbon disk as the working electrode and Ag/Ag⁺ as the reference electrode, standardized for the redox couple ferricenium/ferrocene (Fc/Fc⁺).

Device Fabrication and Measurement

The glass substrates precoated with a 90-nm layer of indium tin oxide (ITO) with a sheet resistance of 15~20 Ω per square are successively cleaned in ultrasonic bath of acetone, isopropanol, detergent and deionized water, respectively, taking 10 minutes for each step. Then, the substrates are totally dried in a 70 °C oven. Before the fabrication processes, in order to improve the hole injection ability of ITO, the substrates are treated by O₂ plasma for 10 minutes. The vacuum-deposited OLEDs are fabricated under a pressure of < 1 × 10⁻⁵ Pa in the Fangsheng OMV-FS450 vacuum deposition system. Organic materials, LiF and Al are deposited at rates of 1~2 A s⁻¹, 0.1 A s⁻¹ and 4 A s⁻¹, respectively. The effective emitting area of the devices is 9 mm², determined by the overlap between anode and cathode. For monochromatic OLEDs, the luminance-voltage-current density characteristics and EL spectra are obtained via a Konica Minolta CS-200 Color and Luminance Meter and an Ocean Optics USB 2000+ spectrometer, along with a Keithley 2400 Source Meter. The external quantum efficiencies are estimated utilizing the normalized EL spectra and the current efficiencies of the devices, assuming that the devices are Lambertian emitters. All the characterizations are conducted at room temperature in ambient conditions without any encapsulation except the lifetime devices.

Carrier mobility measurement

The SCLC property can be described via the Mott-Gurney equation (S1), and the carrier mobility (μ) of organic semiconductors can be calculated according to the Poole–Frenkel formula (S2), where the ε_0 is the free-space permittivity ($8.85 \times 10^{-14} \text{ C V}^{-1} \text{ cm}^{-1}$), ε_r is the relative dielectric constant (assumed to be 3.0 for organic semiconductors), E is the electric field, μ_0 is the zero-field mobility, and γ is the Poole-Frenkel factor and L is the thickness of the neat film of each molecule.^{1,2}

$$J = \frac{9}{8} \varepsilon_0 \varepsilon_r \mu \frac{E^2}{L} = \frac{9}{8} \varepsilon_0 \varepsilon_r \frac{V^2}{L^3} \mu_0 \exp\left(0.891 \gamma \sqrt{\frac{V}{L}}\right) \quad (\text{S1})$$

$$\mu = \mu_0 \exp(\gamma \sqrt{E}) \quad (\text{S2})$$

By fitting the current density–voltage curves in SCLC region according to Equation (S1), the μ_0 and γ values are obtained, thus generating the field-dependent carrier mobility by equation (S2).

Additional Spectra and Tables

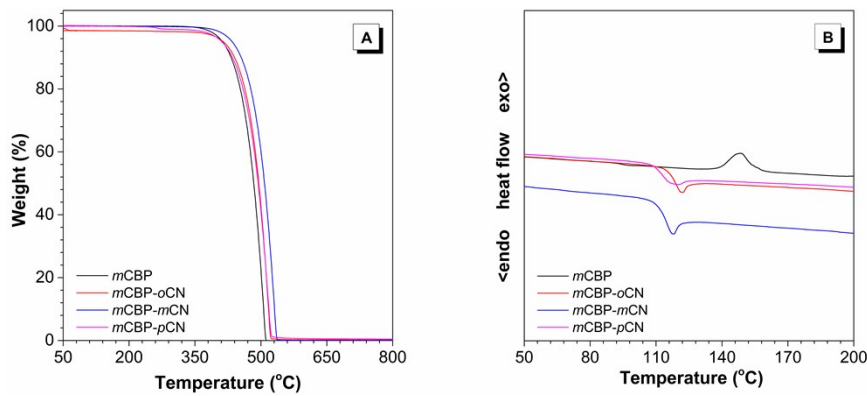


Fig. S1 (A) Thermogravimetric analysis (TGA) and (B) differential scanning calorimeter (DSC) curve of *mCBP-oCN*, *mCBP-mCN*, *mCBP-pCN* and *mCBP*, measured under nitrogen at a scan rate of $10 \text{ }^\circ\text{C s}^{-1}$.

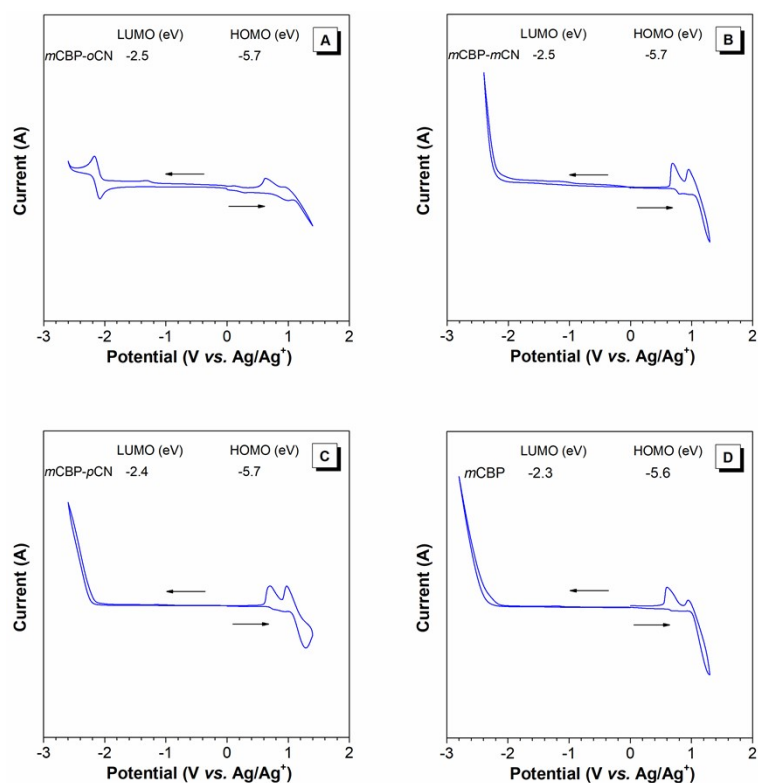


Fig. S2 Cyclic voltammograms of (A) *mCBP-oCN*, (B) *mCBP-mCN*, (C) *mCBP-pCN* and (D) *mCBP*, measured in dichloromethane.

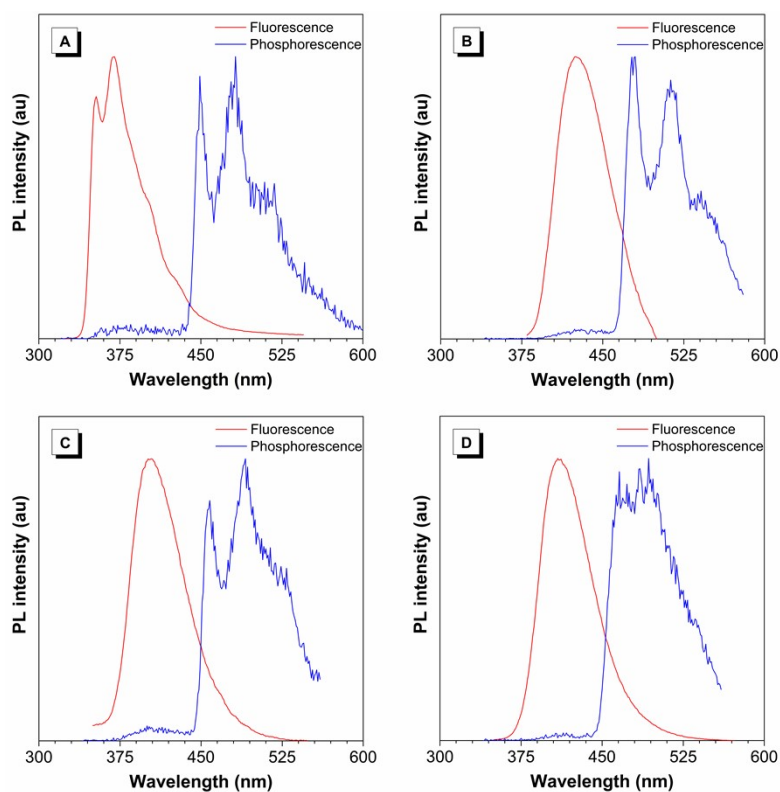


Fig. S3 Fluorescence and phosphorescence spectra of the neat films of (A) *mCBP*, (B) *mCBP-oCN*, (C) *mCBP-mCN* and (D) *mCBP-pCN*, measured at 77 K.

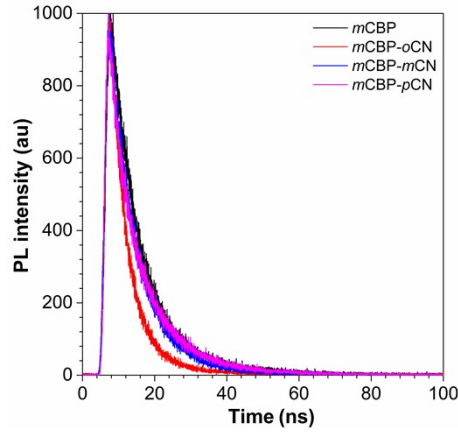


Fig. S4 Transient PL decay spectra of the neat films of *mCBP*, *mCBP-oCN*, *mCBP-mCN*, and *mCBP-pCN*, measured at 298 K in the N_2 atmosphere.

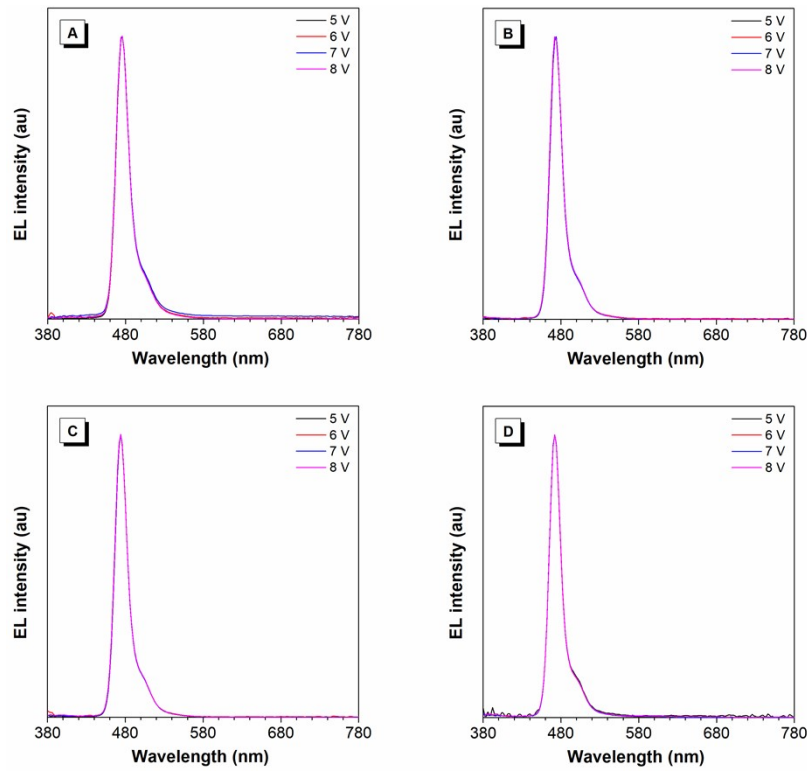


Fig. S5 EL spectra of the devices based on 1 wt% *v*-DABNA doped in the hosts of (A) *mCBP-oCN*, (B) *mCBP-mCN*, (C) *mCBP-pCN* and (D) *mCBP* at different voltages.

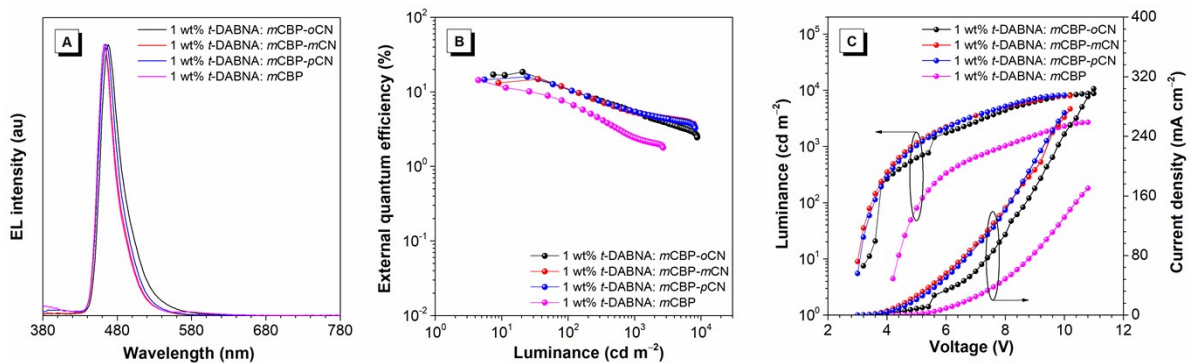


Fig. S6 (A) EL spectra measured at 5 V, (B) external quantum efficiency curves with the change of luminance and (C) luminance and current density curves with the change of voltage of the devices with *t*-DABNA emitter.

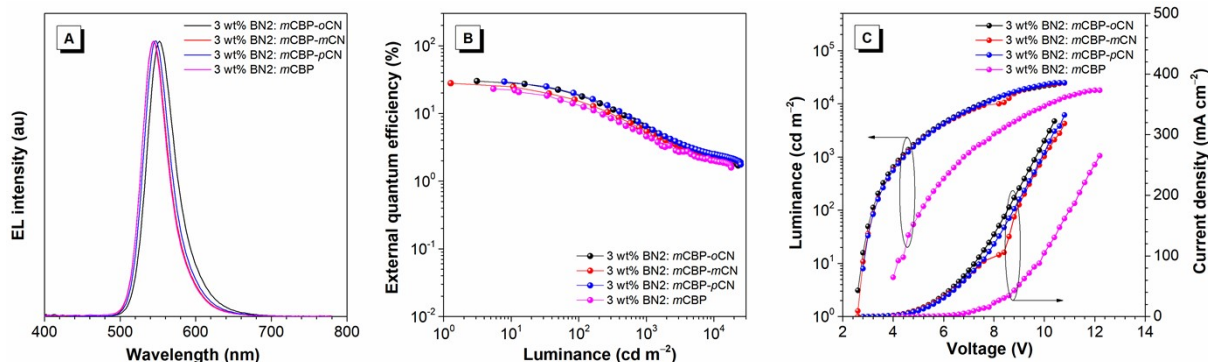


Fig. S7 (A) EL spectra measured at 5 V, (B) external quantum efficiency curves with the change of luminance and (C) luminance and current density curves with the change of voltage of the devices with BN2 emitter.

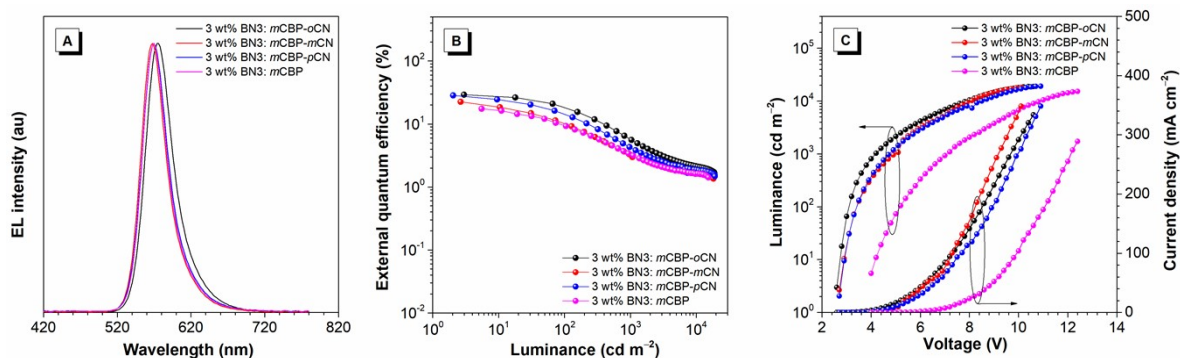


Fig. S8 (A) EL spectra measured at 5 V, (B) external quantum efficiency curves with the change of luminance and (C) luminance and current density curves with the change of voltage of the devices with BN3 emitter.

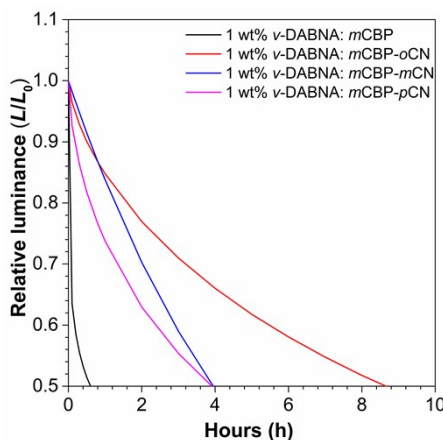


Fig. S9 The operational lifetimes of the devices with *v*-DABNA emitter and different host materials.

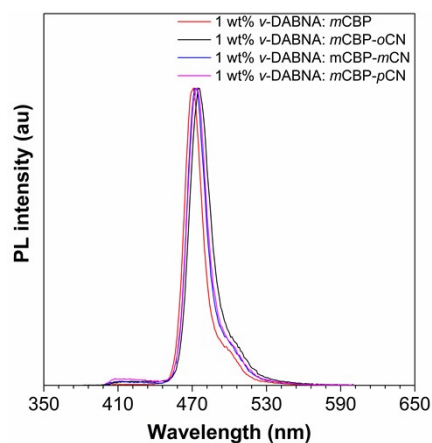


Fig. S10 PL spectra of ν -DABNA in different host materials.

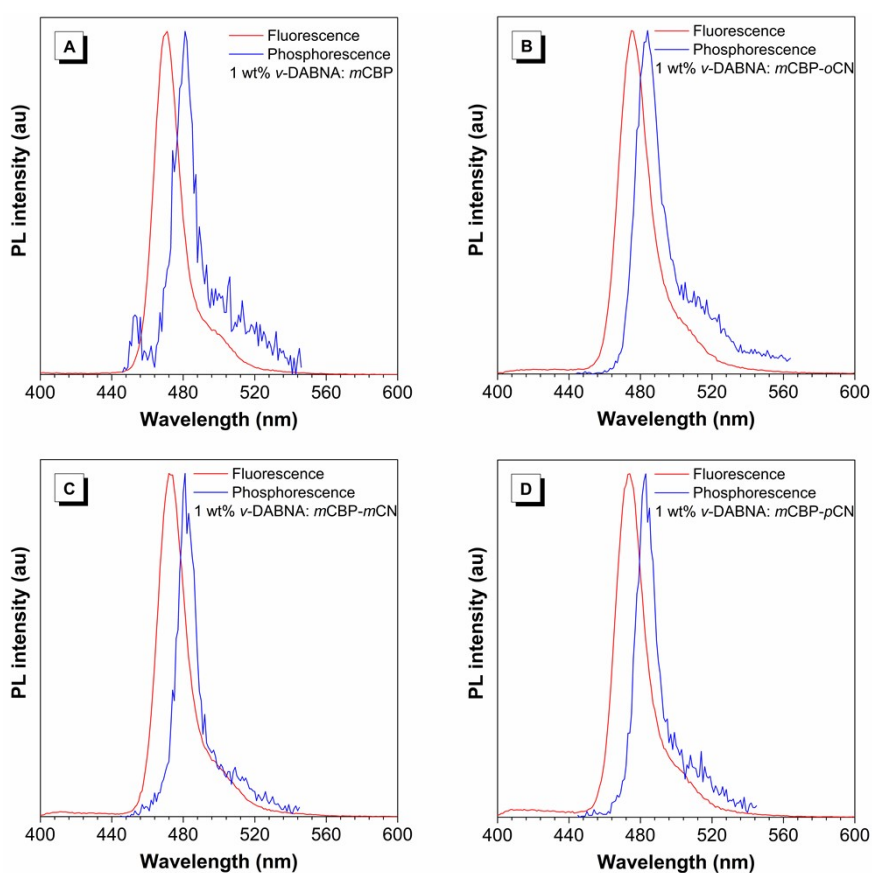


Fig. S11 Fluorescence and phosphorescence spectra of ν -DABNA in different host materials of (A) *mCBP*, (B) *mCBP-oCN*, (C) *mCBP-mCN* and (D) *mCBP-pCN*. Fluorescence spectra are measured at 298 K, and phosphorescence spectra are measured at 77 K.

Table S1. The EL performance of the OLEDs with *t*-DABNA emitter in different host materials.

Host ^{a)}	λ_{EL} (nm)	V_{on} (V)	L_{max} (cd m ⁻²)	CE (cd A ⁻¹)	PE (lm W ⁻¹)	EQE (%)	CIE (x, y)	FWHM (nm)
				maximum value/at 1000 cd m ⁻²				
<i>m</i> CBP- <i>o</i> CN	468	3.1	8754	21.7/6.8	18.5/5.6	18.5/5.8	(0.128, 0.156)	28
<i>m</i> CBP- <i>m</i> CN	464	2.9	7962	12.7/4.6	12.4/3.0	14.8/5.4	(0.128, 0.099)	27
<i>m</i> CBP- <i>p</i> CN	466	2.9	8176	14.7/5.0	14.4/3.1	16.0/5.4	(0.126, 0.111)	28
<i>m</i> CBP	462	4.1	2690	12.7/2.1	9.5/0.8	14.4/2.4	(0.149, 0.116)	25

^{a)} Abbreviations: V_{on} = turn-on voltage at 1 cd m⁻²; L_{max} = maximum luminance; CE/PE/EQE = current efficiency/power efficiency/external quantum efficiency at maximum value and 1000 cd m⁻²; CIE = Commission Internationale de l'Eclairage coordinates at 1000 cd m⁻²; FWHM = full-width at half-maximum. The doping concentration is 1 wt%.

Table S2. The EL performance of the OLEDs with BN2 emitter in different host materials.

Host ^{a)}	λ_{EL} (nm)	V_{on} (V)	L_{max} (cd m ⁻²)	CE (cd A ⁻¹)	PE (lm W ⁻¹)	EQE (%)	CIE (x, y)	FWHM (nm)
				maximum value/at 1000 cd m ⁻²				
<i>m</i> CBP- <i>o</i> CN	552	2.5	22900	125.6/24.2	151.6/17.3	30.1/5.8	(0.374, 0.613)	43
<i>m</i> CBP- <i>m</i> CN	544	2.5	24543	119.4/23.3	144.3/16.6	28.0/5.5	(0.333, 0.650)	40
<i>m</i> CBP- <i>p</i> CN	548	2.7	24938	125.9/27.9	141.2/19.9	29.6/6.5	(0.347, 0.638)	42
<i>m</i> CBP	544	3.9	18002	98.8/19.7	77.6/9.1	23.2/4.6	(0.326, 0.652)	40

^{a)} Abbreviations: V_{on} = turn-on voltage at 1 cd m⁻²; L_{max} = maximum luminance; CE/PE/EQE = current efficiency/power efficiency/external quantum efficiency at maximum value and 1000 cd m⁻²; CIE = Commission Internationale de l'Eclairage coordinates at 1000 cd m⁻²; FWHM = full-width at half-maximum. The doping concentration is 3 wt%.

Table S3. The EL performance of the OLEDs with BN3 emitter in different host materials.

Host ^{a)}	λ_{EL} (nm)	V_{on} (V)	L_{max} (cd m ⁻²)	CE (cd A ⁻¹)	PE (lm W ⁻¹)	EQE (%)	CIE (x, y)	FWHM (nm)
				maximum value/at 1000 cd m ⁻²				
<i>m</i> CBP- <i>o</i> CN	574	2.5	18876	103.4/19.8	125.0/14.8	29.3/5.6	(0.496, 0.500)	43
<i>m</i> CBP- <i>m</i> CN	568	2.6	18189	86.4/12.7	100.6/8.1	22.5/3.3	(0.454, 0.541)	40
<i>m</i> CBP- <i>p</i> CN	570	2.6	19081	105.7/16.0	123.0/10.7	28.6/4.3	(0.467, 0.529)	41
<i>m</i> CBP	570	3.9	15324	65.2/12.7	51.2/5.7	17.5/3.4	(0.464, 0.532)	39

^{a)} Abbreviations: V_{on} = turn-on voltage at 1 cd m⁻²; L_{max} = maximum luminance; CE/PE/EQE = current efficiency/power efficiency/external quantum efficiency at maximum value and 1000 cd m⁻²; CIE = Commission Internationale de l'Eclairage coordinates at 1000 cd m⁻²; FWHM = full-width at half-maximum. The doping concentration is 3 wt%.

Table S4. Structures of films I–IV.

film	structure
I	1 wt% ν -DABNA: <i>m</i> CBP- <i>o</i> CN
II	1 wt% ν -DABNA: <i>m</i> CBP- <i>m</i> CN
III	1 wt% ν -DABNA: <i>m</i> CBP- <i>p</i> CN
IV	1 wt% ν -DABNA: <i>m</i> CBP

Table S5. Photophysical properties of ν -DABNA in doped films with different hosts.

Host ^{a)}	λ_{PL} (nm)	ΔE_{ST} (meV)	Φ_{PL} (%)	$\Theta_{//}$ (%)
<i>m</i> CBP- <i>o</i> CN	476	47	84	89.0
<i>m</i> CBP- <i>m</i> CN	472	49	80	89.5
<i>m</i> CBP- <i>p</i> CN	474	49	82	92.5
<i>m</i> CBP	470	60	61	86.0

^{a)} Abbreviations: λ_{PL} = photoluminescence peak; ΔE_{ST} = energy splitting between S_1 and T_1 states; Φ_{PL} = photoluminescence quantum yield; $\Theta_{//}$ = horizontal dipole ratio.

Reference

- 1 G. Lin, H. Peng, L. Chen, H. Nie, W. Luo, Y. Li, S. Chen, R. Hu, A. Qin, Z. Zhao and B. Z. Tang, *ACS Appl. Mater. Interfaces*, 2016, **8**, 16799.
- 2 C. Liu, T. Li, M. Sun, M. Xie, Y. Zhou, W. Feng, Q. Sun, S.-T. Zhang, S. Xue and W. Yang, *Adv. Funct. Mater.*, 2023, **33**, 2215066.