Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Electronic Supplementary Information

High T_g Small-Molecule Phenanthroline Derivatives as a Potential Universal Hole-Blocking Layer for High Power-Efficiency and Stable Organic Light-Emitting Diodes

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Fig. S1-1 ^{1}H NMR of compound **2** ($CDCl_3$, 400 MHz).

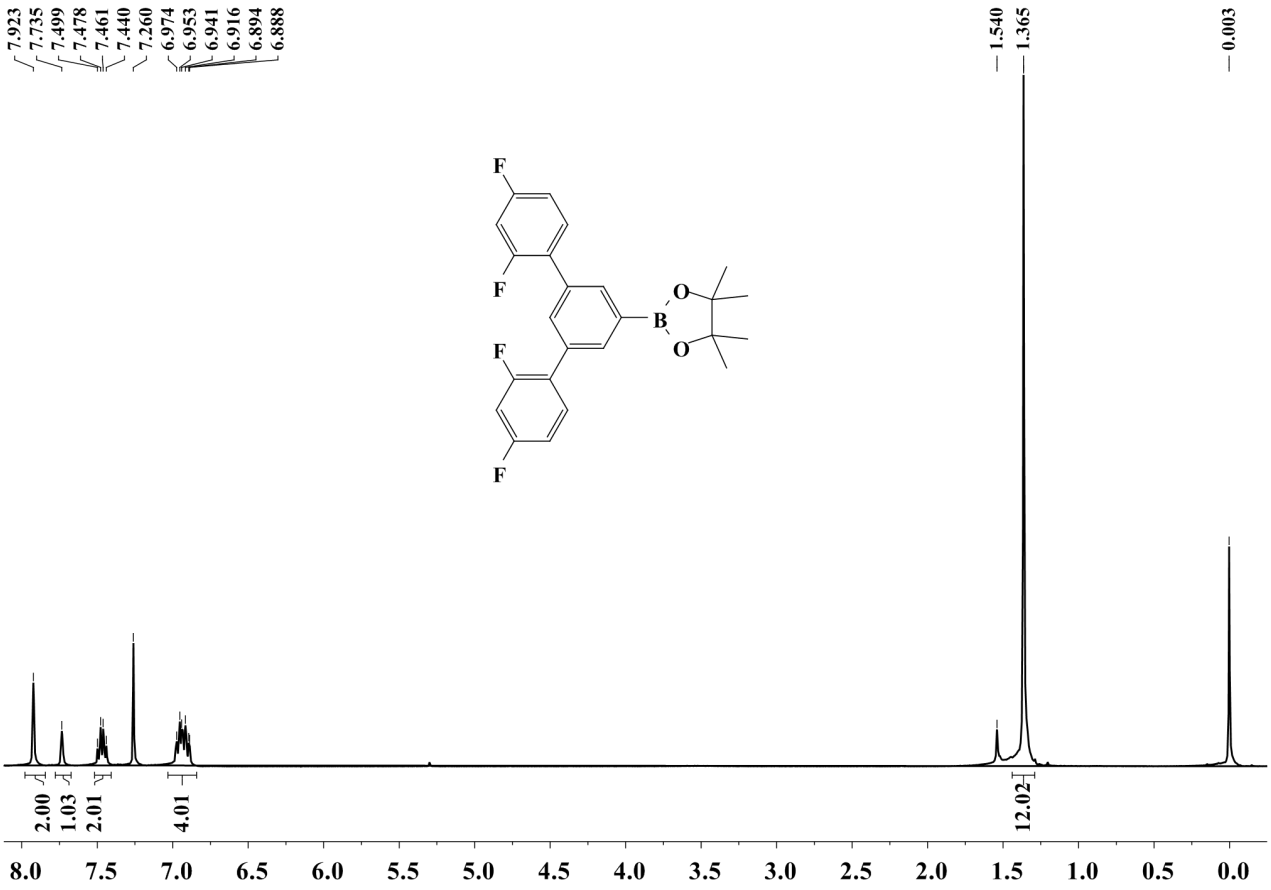


Fig. S1-2 ^{1}H NMR of compound **3** ($CDCl_3$, 400 MHz).

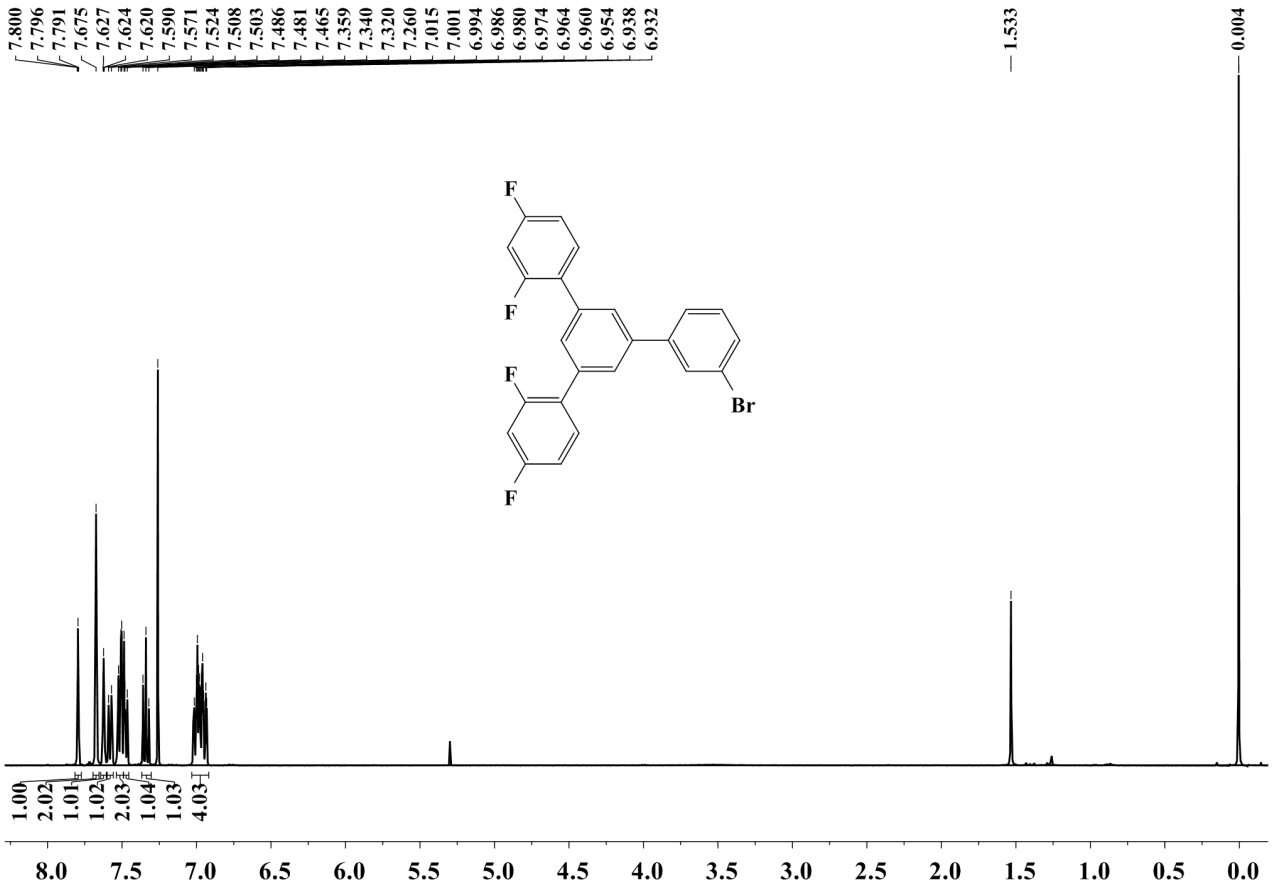


Fig. S1-3 ^{1}H NMR of compound **4** ($CDCl_3$, 400 MHz).

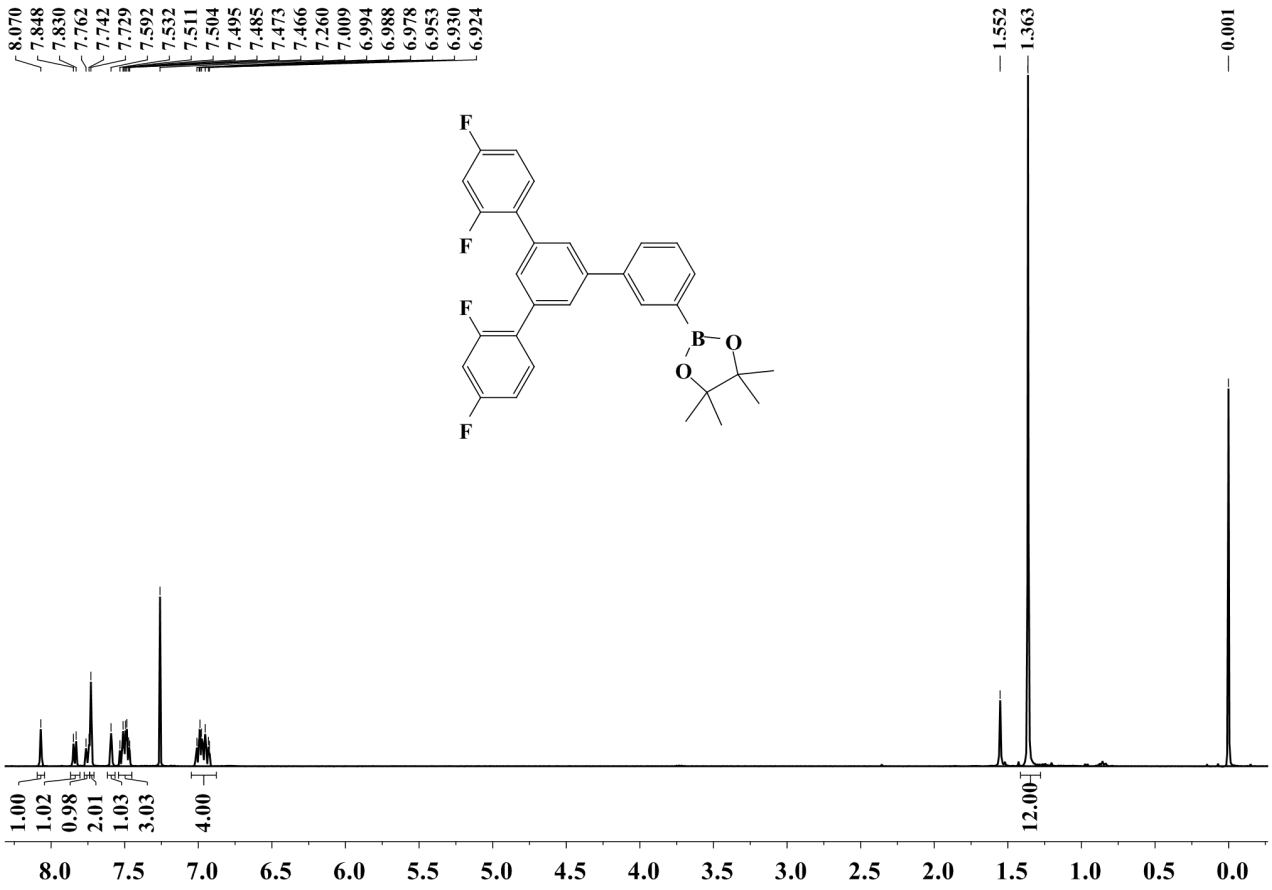


Fig. S1-4 ^{1}H NMR of **Phen-DFP** ($CDCl_3$, 400 MHz).

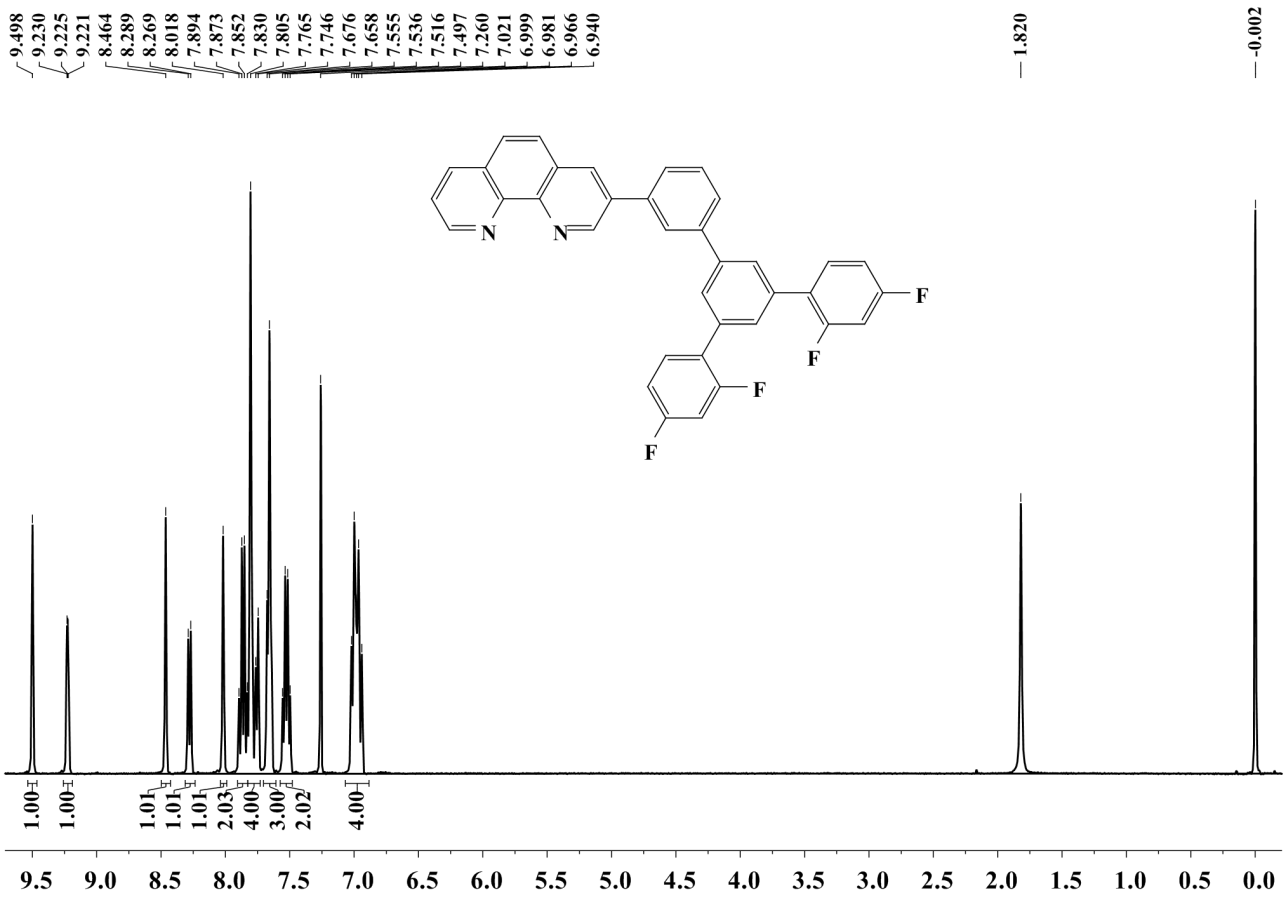


Fig. S2 Microanalysis data of compound **Phen-DFP**: provided by the Instrumental Analysis & Research Center, Sun Yat-Sen University, Guangzhou, China

Document: 20160426 CHN test (varioELcube) from: 2016/4/27 7:55:12

CHN元素含量分析
varioELcube CHNS/O 元素分析仪
serial number: 19152014

Text report

No.	Name	Weight [mg]	C [%]	H [%]	N [%]	C/N ratio	C/H ratio	Date Time
93	Phen-DFP	1.9920	77.37	3.717	4.91	15.7495	20.8156	26.04.2016 22:11

Fig. S3 (a) Thermogravimetric analysis and (b) DSC diagrams of **Phen-DFP**.

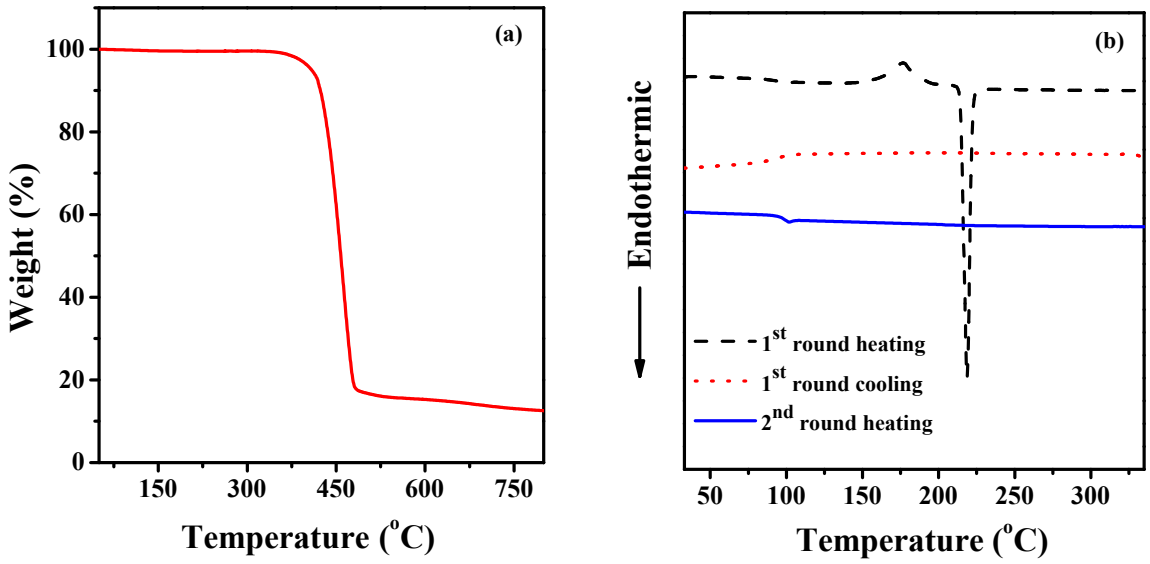


Fig. S4 UPS spectrum at the low-kinetic energy part (a) and valence band spectrum near the Fermi level (b) for **Phen-DFP** (10 nm) on the ITO surface.

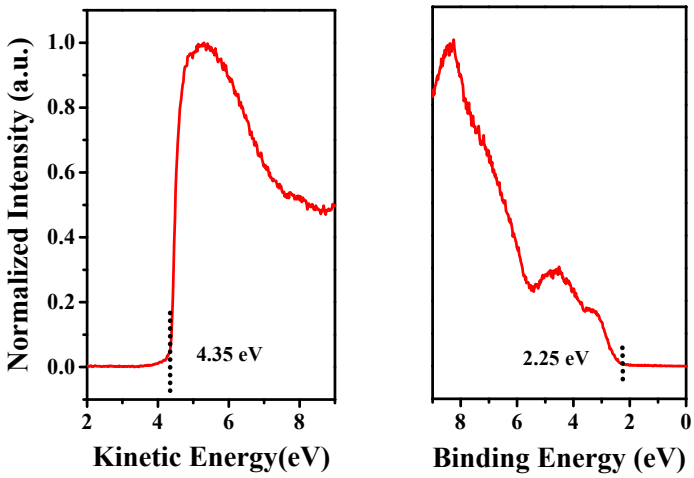


Fig. S5 The chemical structures of the organic charge-transport materials involved in the sky blue FLOLEDs, green and red PHOLEDs with their HOMO and LUMO levels, as well as the *p*-type dopant F4-TCNQ.

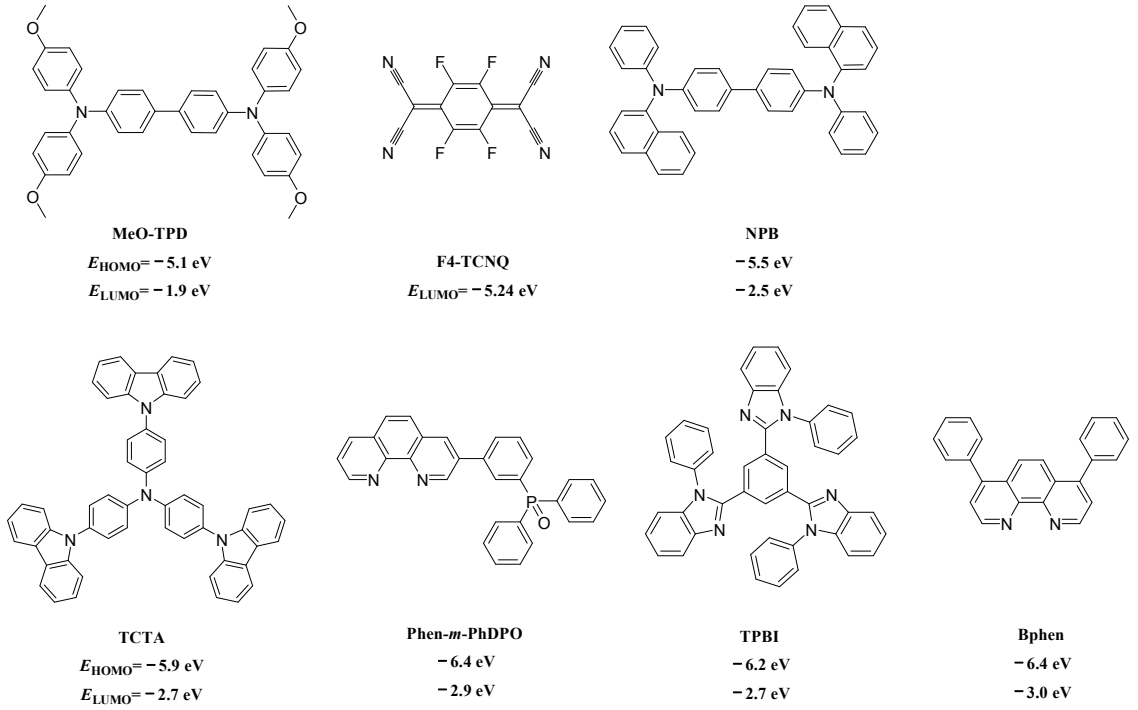


Fig. S6 The energy diagrams of the *pin* OLEDs

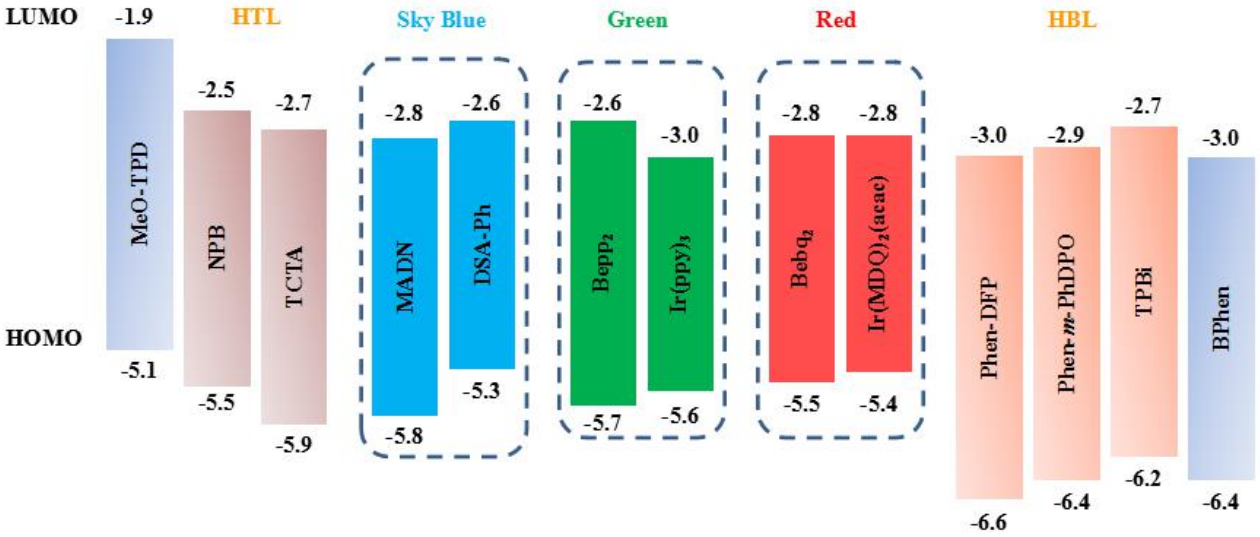


Fig. S7 EL characteristics of **Phen-DFP** based sky blue FLOLEDs with (w) and without (w/o) a TCTA layer: (a) *J-V-L*, (b) *LE-L*, (c) *PE-L* and (d) EL spectra.

- ITO/MeO-TPD:F4-TCNQ(100 nm, 4%)/**NPB(20 nm)**/MADN:7%DSA-Ph (30 nm)/**Phen-DFP** (10 nm)/Bphen:Cs_2CO_3(20 nm, 50%)/Al(200 nm)
- ITO/MeO-TPD:F4-TCNQ(100 nm, 4%)/**NPB(15 nm)/TCTA(5 nm)** /MADN:7%DSA-Ph (30 nm)/**Phen-DFP**(10 nm)/Bphen:Cs_2CO_3(20 nm, 50%)/Al(200 nm)

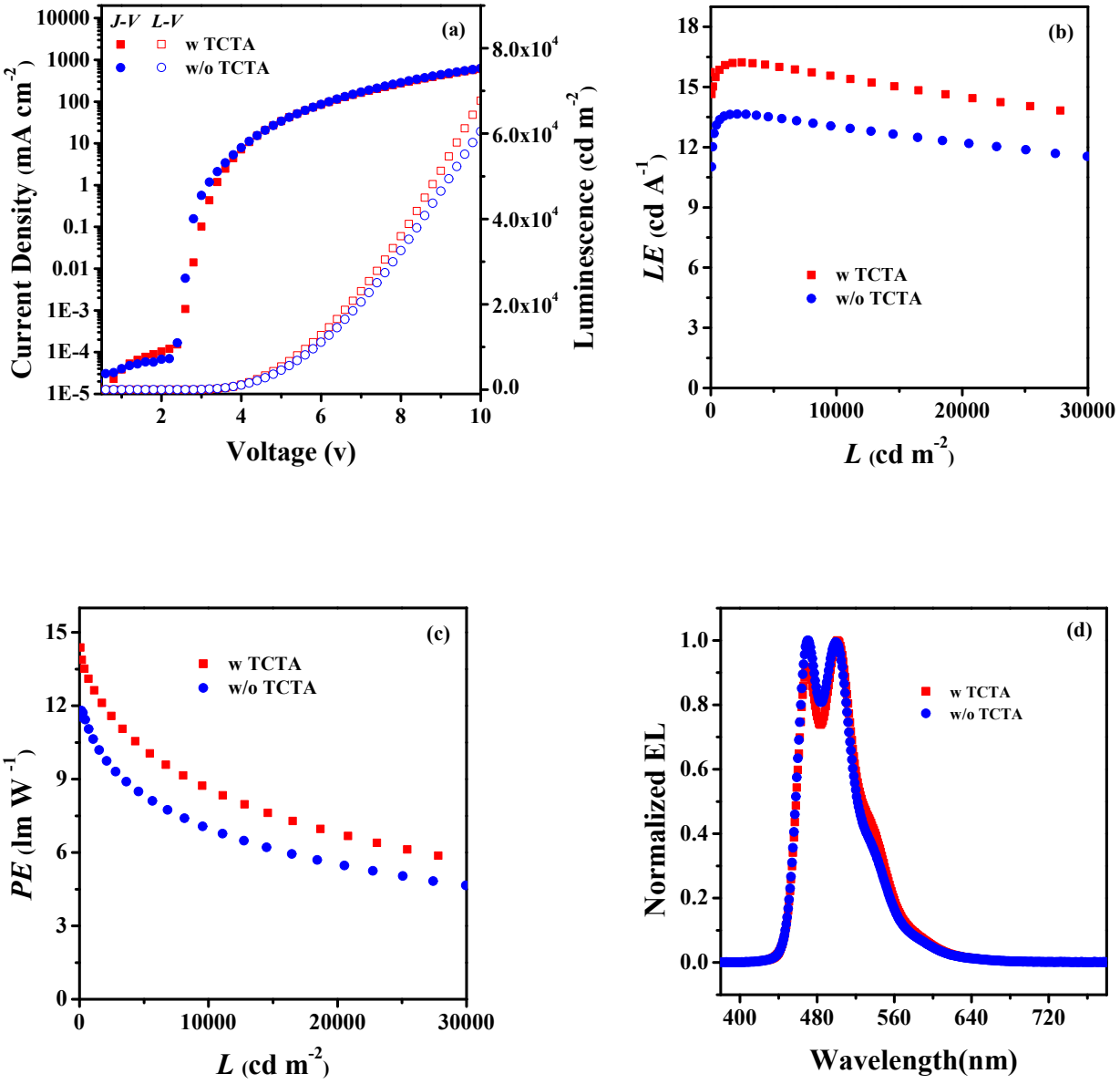


Table S1 Summary of the Electroluminescent dada

HBL	Sky Blue FLOLEDs	V_{on}[a] [v]	@100 cd m^{-2}			@1000 cd m^{-2}			
			LE [cd A^{-1}]	PE [lm W^{-1}]	V [v]	J [mA cm^{-2}]	LE [cd A^{-1}]	PE [lm W^{-1}]	EQE [%]
Phen-DFP	w/ TCTA	2.8	14.8	14.2	3.9	6.2	16.0	12.8	7.2
	w/o TCTA	2.8	11.5	11.7	4.0	7.7	13.5	10.7	6.5
Phen-*m*-PhDPO	w/ TCTA	2.8	14.2	13.9	3.8	6.3	15.8	13.0	7.2
	w/o TCTA[b]	2.8	8.9	8.2	4.0	8.9	11.4	8.9	5.4
TPBI	w/ TCTA	2.8	13.7	14.0	3.9	6.2	16.1	13.1	7.4
	w/o TCTA[b]	3.0	9.8	7.0	5.4	10.0	10.6	6.2	5.09

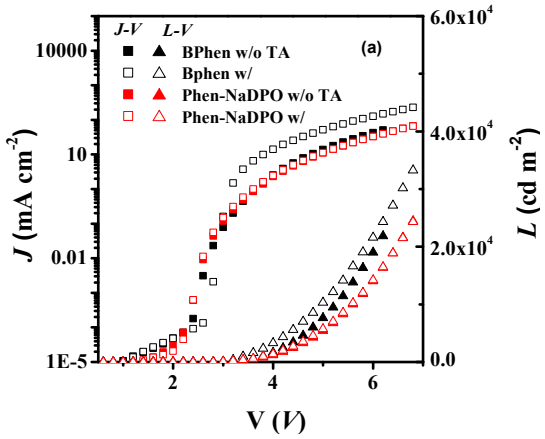
[a]At a luminescence of ~1-3 cd m^{-2}

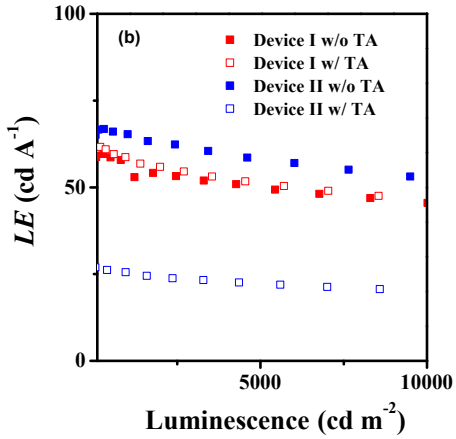
[b] Data cited from [Ref. 1]

Fig. S8 *J–V–L* (a) *and LE–L* (b) characteristics of the green PHOLEDs (ITO/MoO_3/TAPC:MoO_3 (45 nm, 15%)/ TAPC(15 nm)/TCTA:Ir(ppy)$_2$(acac)(20 nm, 8%)/HBL(10 nm)/ETL:Li_2CO_3(40 nm, x%)/Li_2CO_3(1 nm)/Al): without (solid square) and with (hollow square) thermal annealing (TA) at 80 °C for 15 min.

Device I: HBL = **Phen-*m*-PhDPO**, ETL = **Phen-NaDPO**, 5% Li_2CO_3

Device II: HBL = BPhen, ETL = BPhen, 3% Li_2CO_3





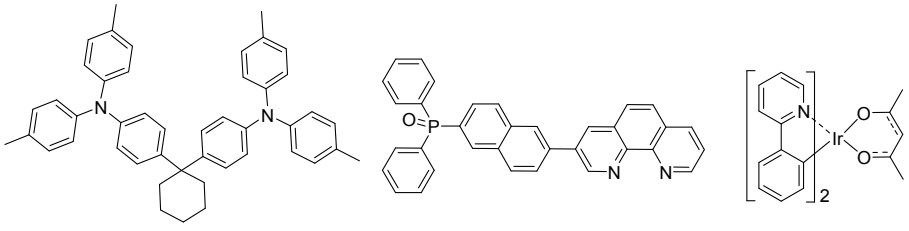


Fig. S9 $J-V$ characteristics of the electron-only devices: ITO/HBL(10 nm)/ETL:Li_2CO_3(70 nm, x%)/Li_2CO_3(1 nm)/Al, without (solid square) and with (hollow square) thermal annealing (TA) at 80 °C for 15 min.

Device III: HBL= **Phen-*m*-DPO**, ETL = **Phen-NaDPO**, 5% Li_2CO_3

Device IV: HBL = ETL = BPhen, 3% Li_2CO_3

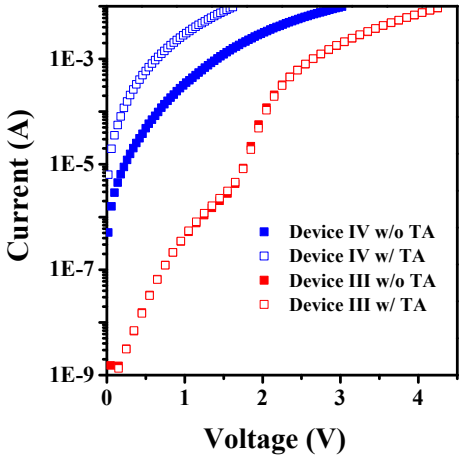
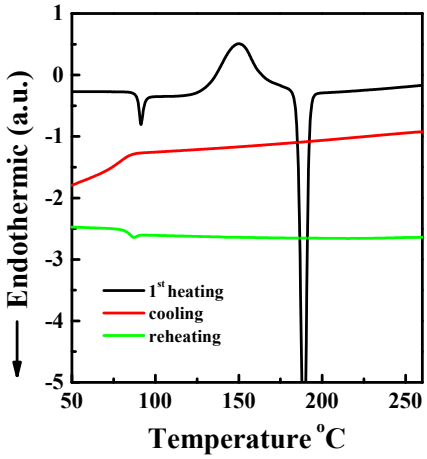


Fig. S10. DSC diagrams of **TAPC**.



Reference

[1] W.-Y. Tan, J.-H. Zou, D.-Y. Gao, J.-Z. Liu, N.-N. Chen, X.-H. Zhu, J. B. Peng and Y. Cao, *Adv. Electron. Mater.,* 2016, **2**, 1600101.