Supplementary Information

Highly-efficient fully non-doped white organic light-emitting diodes consisting entirely of thermally activated delayed fluorescence emitters

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Experimental

Materials and methods

The yellow TADF emitter OPDPO was synthesized according to our previous method, wherein the phenothiazine group acts as the donor, the central benzophenone core and the diphenylphosphoryl group act as electron acceptor, enabling a charge transfer state which can induce broad emission spectrum to improve the color rendering index (CRI) for two-color WOLEDs. DMACDPS, poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS), 4,4'-bis(9H-carbazol-9-yl)biphenyl (CBP), m-bis(N-carbazolyl)benzene (mCP), bis(2-(diphenylphosphino)phenyl)ether oxide (DPEPO) and 1,3,5-tris(N-phenylbenzimidazol-2-yl)benzene (TPBI) were purchased from Xi'an Polymer Light Technology Co. Ltd. (Xi'an, Shanxi province, China) and used without any further purification. The molecular structures of OPDPO and DMACDPS are shown in Figure 1.

PL characterization

PL spectra and UV-vis absorption spectra were measured using a Shimadzu RF-5301PC spectrometer and a Hitachi U-3900 spectrophotometer, respectively. Transient PL decay characteristics were recorded on a Quantaurus-Tau system equipped with an Oxford OptistatDN.

Supplementary Tables and Figures

Table S1. Summary of device performances of the reported all-TADF WOLEDs. This work demonstrates an all-TADF WOLED with fully non-doped emissive layers, and references 1-7 reporte all-TADF WOLEDs using doped emissive layers which require each TADF emitter to be dispersed into a host matrix.

EMLs structure	λ_{EL} [a] (nm)	CE [b] (cd A^{-1})	PE [b] (lm W^{-1})	EQE [b] (%)	Reference
OPDPO/DMACDPS	486,566	41.4	21.7	19.8	This work
SFXSPO:**4CzPNPh** SFXSPO:**TPXZPO**	480,564	42.3	38.0	16.3	Ref. 1
CBP:**5** / PPF:**2**	489,548	16.4	-	6.7	Ref. 2
SFXSPO:**4CzPNPh**/ SFXSPO:**DMACDPS**	484,556	50.5	40.6	19.1	Ref. 3
CBP:**3,6-2TPA-TXO**/CBP /CBP:**3,6-2TPA-TX**	478,577	49.5	48.6	20.4	Ref. 4
CDBP:PO-T2T:**AnbTPA**/ CDBP:PO-T2T/CDBP: PO-T2T:**2CzPN**	492,600	36.7	46.2	19.2	Ref. 5
5CzOXD:**4CzPNPh**	487,556	21.6	26.1	7.2	Ref. 6
mCBP:**4CzPN**/mCBP:**4CzPN**:**4CzTPN-Ph**/PPT:**3CzTRZ**	480,568	40.3	33.4	17.1	Ref. 7

[a] Electroluminescent peak wavelength. [b] Maximum current efficiency (CE), power efficiency (PE) and external quantum efficiency (EQE).

SFXSPO, CBP, PPF, SFXSPO, CBP, CDBP, PO-T2T, mCBP and PPT are host materials. OPDPO, 4CzPNPh, 2, and 3,6-2TPA-TXO are yellow TADF emitter materials. DMACDPS, TPXZPO, 5, 3,6-2TPA-TX, 2CzPN, 3CzTRZ and 5CzOXD are blue TADF emitter materials. 4CzPN is a green TADF emitter material. AnbTPA and 4CzTPN-Ph are red TADF emitter materials.

Table S2. Lifetime characteristics of the films.

Lifetime	DMACDPS film	OPDPO film	DMACDPS/OPDPO stacked film	
			DMACDPS	OPDPO
τ_1 (ns)	3.2	6.5	4.0	6.5
τ_2 (μs)	8.8	11.3	3.5	29.1

Abbreviations: τ_1, prompt fluorescence component; τ_2, delayed fluorescence component.

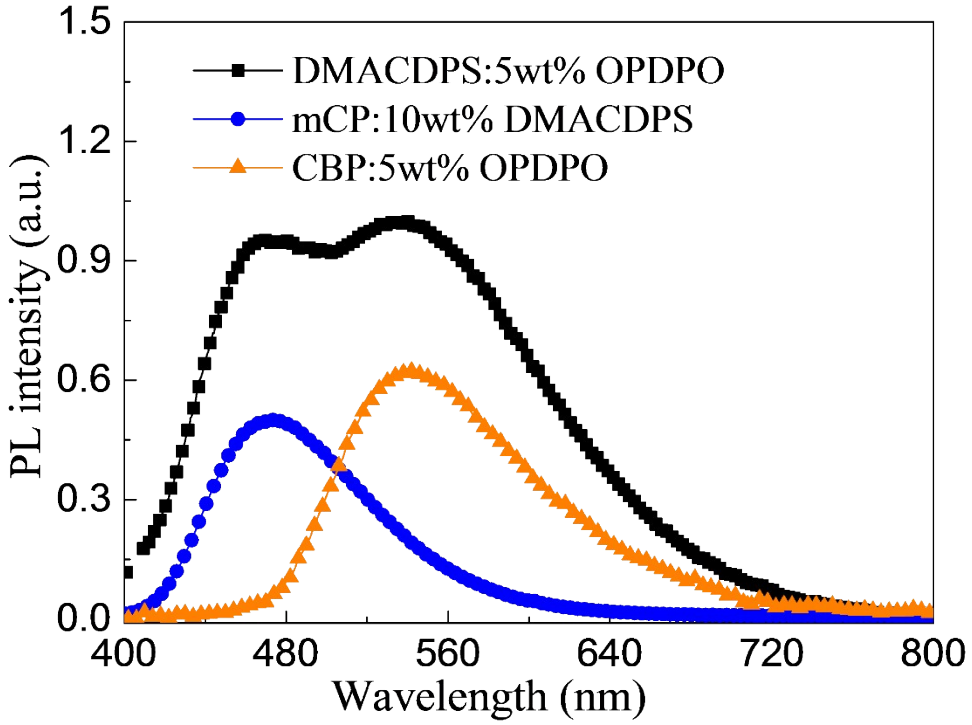

Figure S1. PL spectrum of DMACDPS:5wt%OPDPO doped film (black square), showing two emission peaks at 470 nm and 540 nm, along with PL spectrum of DMACDPS in mCP:10wt%DMACDPS doped film (blue circle), showing a peak at 472 nm and PL spectrum of OPDPO in CBP:5wt%OPDPO doped film (yellow triangle), showing a peak at 542 nm.

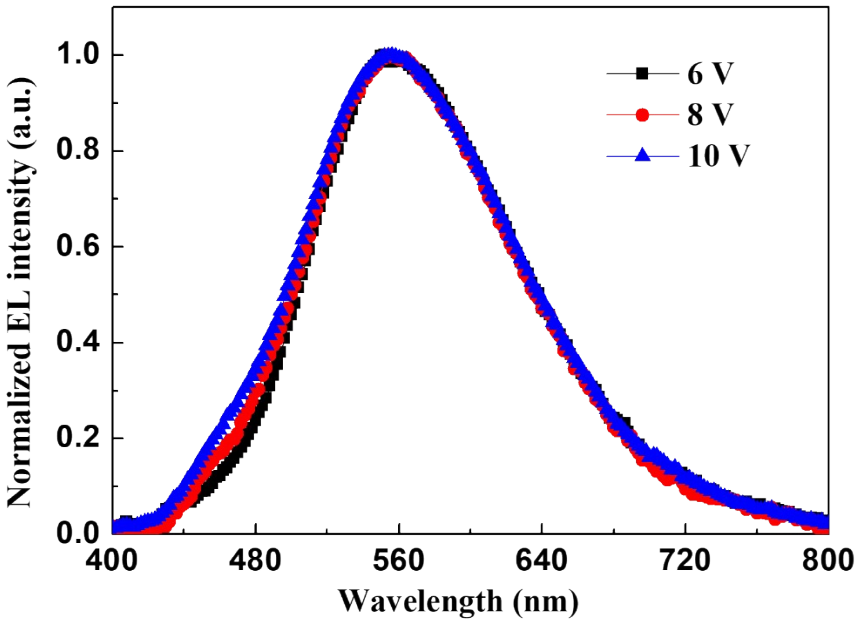

Figure S2. EL spectra at different voltages from a doped OLED with device structure as: ITO/TAPC(60 nm)/DMACDPS: 5wt% OPDPO(20 nm)/TPBI(40 nm)/Mg:Ag.

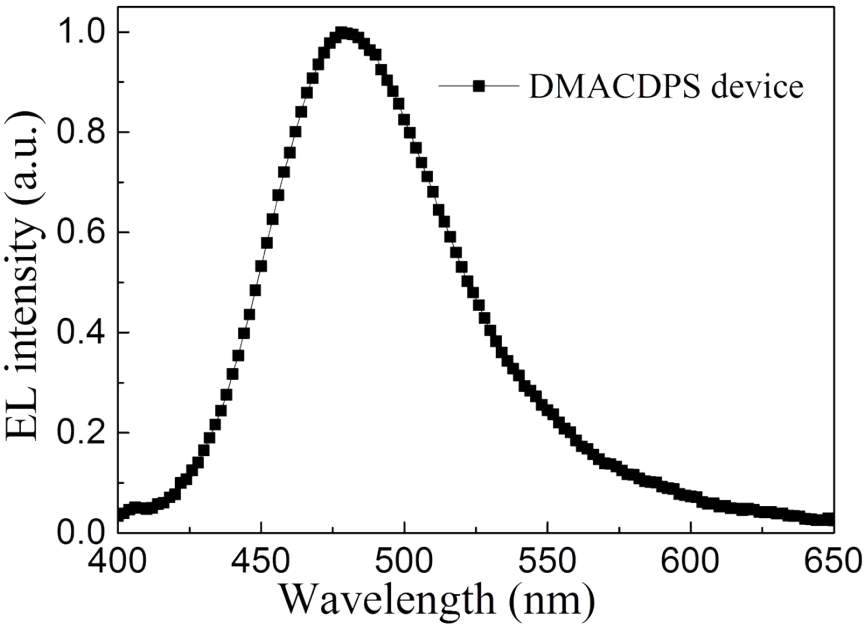

Figure S3. EL spectrum of DMACDPS-OLED with the device structure given as: ITO/ PEDOT:PSS(40 nm)/CBP (20 nm)/DMACDPS (15 nm)/TPBI(40 nm)/Mg:Ag.

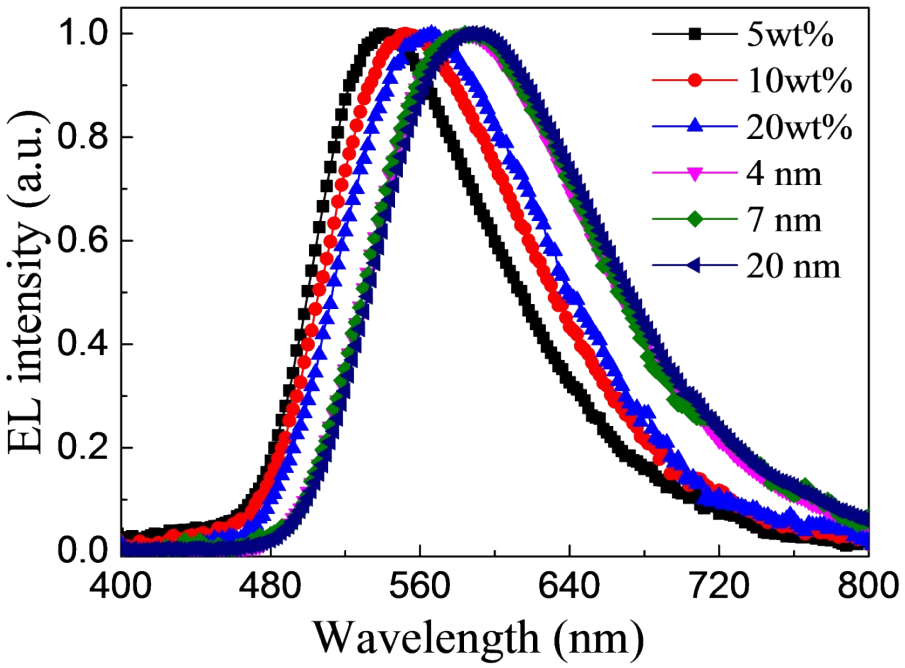

Figure S4. EL spectra of OPDPO-based OLEDs. The doped OPDPO devices are given as: ITO/PEDOT:PSS(40 nm)/CBP(20 nm)/CBP: *X*wt% OPDPO(15 nm)/TPBI(40 nm)/Mg:Ag, wherein the doping ratio *X*= 5, 10 and 20 respectively; the non-doped OPDPO devices are: ITO/PEDOT:PSS(40 nm)/CBP(20 nm)/OPDPO(*Y* nm)/TPBI(40 nm)/Mg:Ag, wherein OPDPO thickness *Y*= 4, 7 and 20 nm respectively.

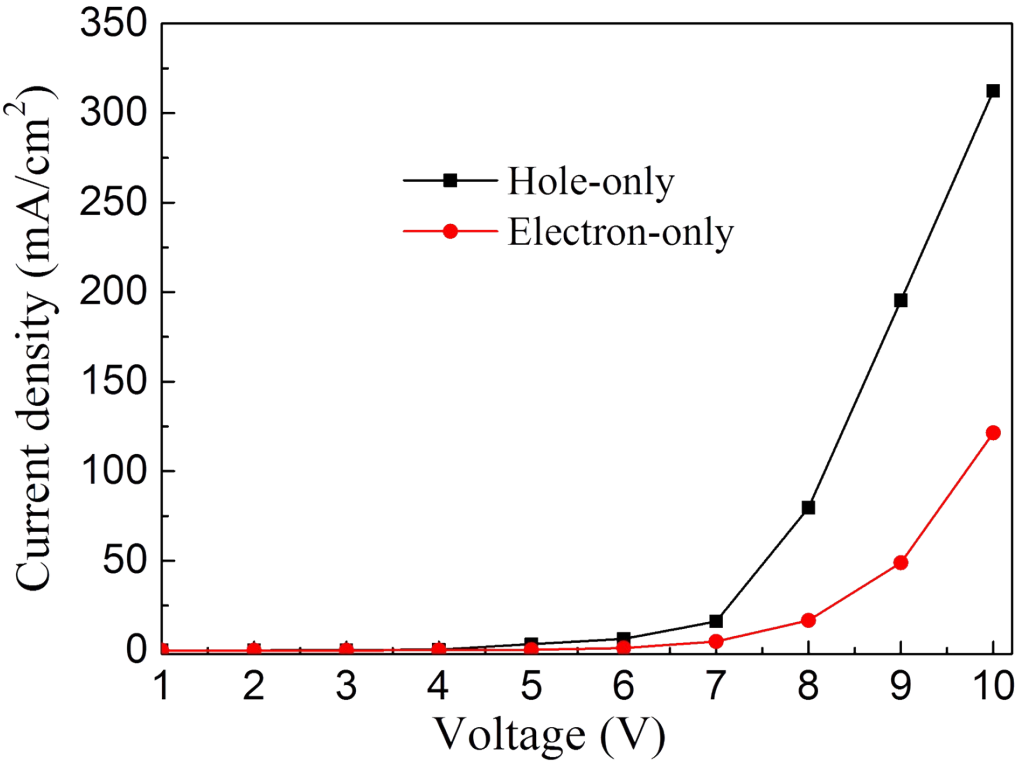

Figure S5. Current density–voltage curves of the single carrier devices. Hole-only device was constructed as: ITO/PEDOT:PSS(40 nm)/CBP(20 nm)/OPDPO(4 nm)/ DMACDPS(15 nm)/CBP(40 nm)/Ag, and electron-only device was: ITO/TPBI(40 nm)/OPDPO(4 nm)/DMACDPS(15 nm)/TPBI(40 nm)/Mg:Ag.

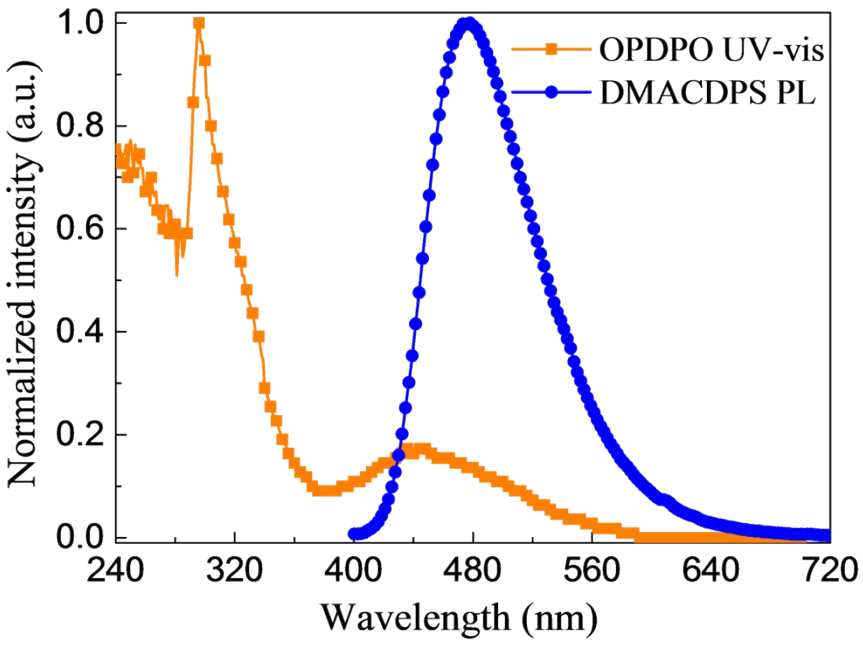

Figure S6. UV-vis absorption spectrum of OPDPO film (yellow square) and PL spectrum of DMACDPS film (blue circle).

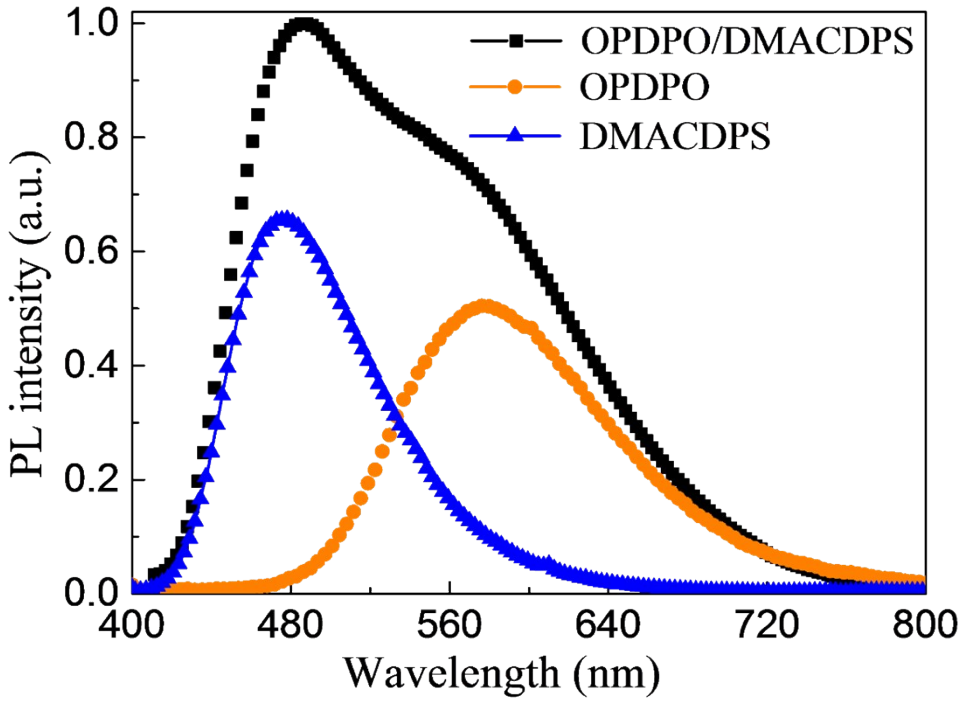

Figure S7. PL spectrum of stacked OPDPO/DMACDPS (4 nm/15 nm) film (black square), PL spectrum of neat DMACDPS film (blue triangle) and PL spectrum of neat OPDPO film (yellow circle).

References

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