Supplementary information

for

Power-efficient and solution-processed red phosphorescent organic light-emitting diodes by choosing the combinations of small molecular materials to form well-dispersed exciplex co-host

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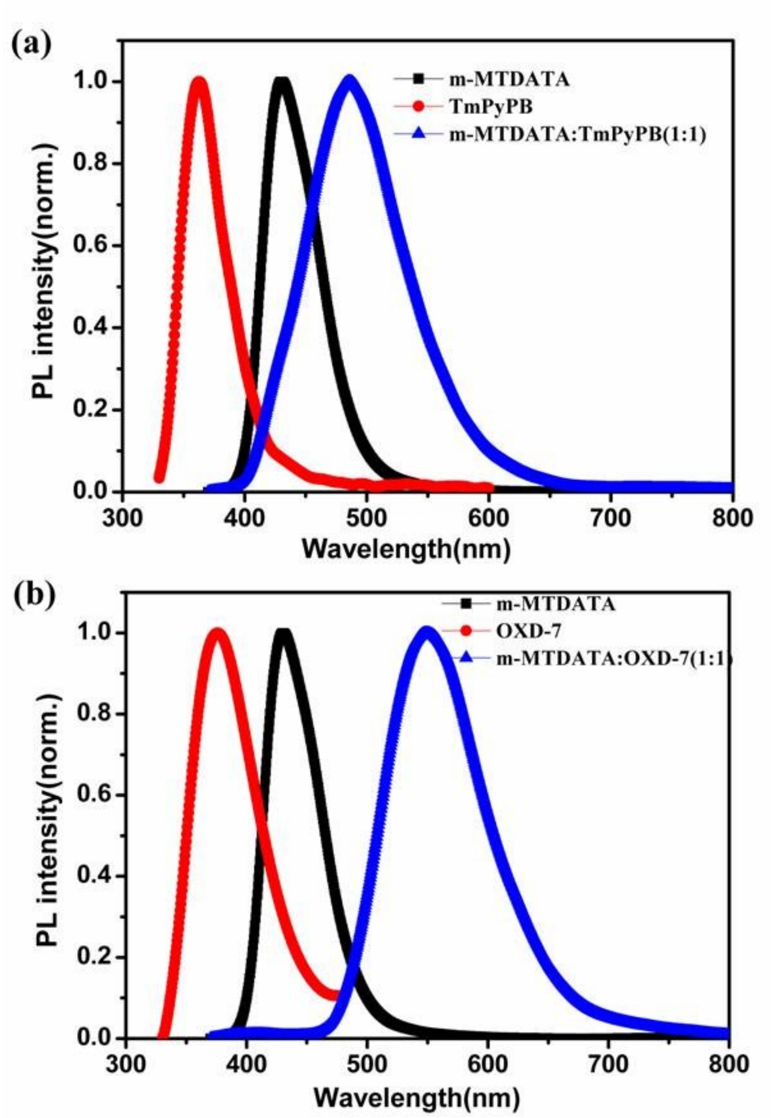


Figure S1. (a) PL spectra of the pure m-MTDATA, TmPyPB and m-MTDATA:TmPyPB (1:1, w/w) films. (b) PL spectra of the pure m-MTDATA, OXD-7 and m-MTDATA:OXD-7(1:1,w/w) films.

As shown, there is distinct PL spectra red-shift for the corresponding binary m-MTDATA:TmPyPB and m-MTDATA:OXD-7 co-host as compared to those of their individual component film samples. Besides, the appeared PL spectra feature with very broad and structureless characteristics.

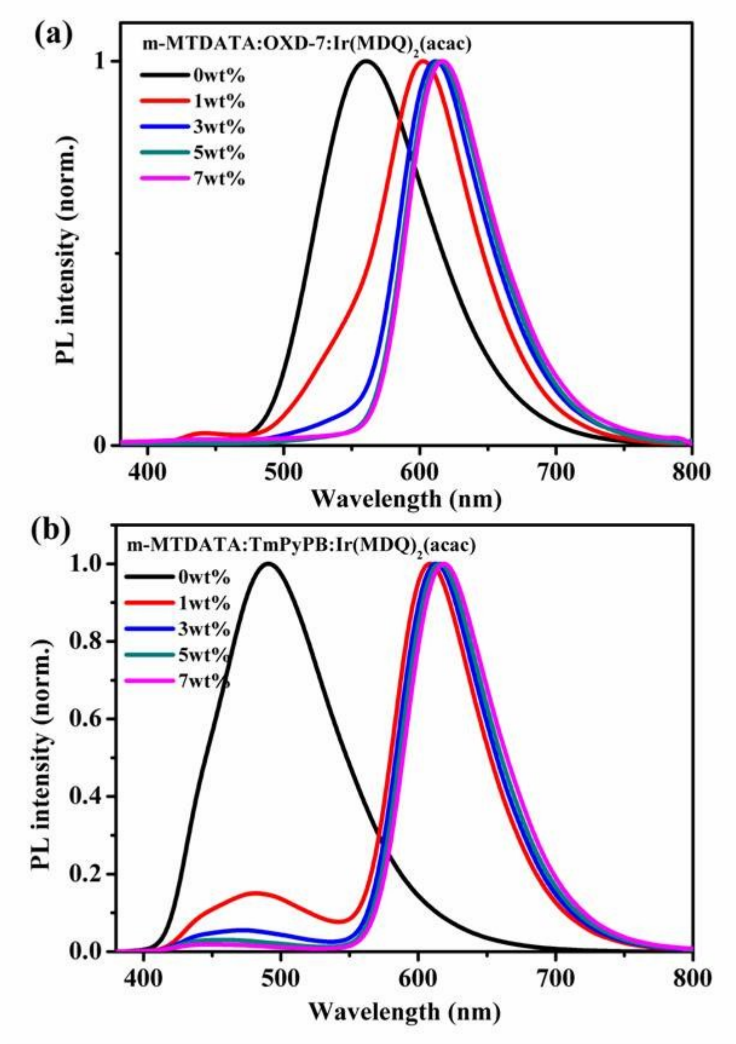


Figure S2. Steady-state PL spectra of the exciplex-forming co-host films of (a) m-MTDATA:OXD-7(1:1, w/w) and (b) m-MTDATA:TmPyPB(1:1, w/w) doped with red $Ir(MDQ)_2acac$ at different concentrations (0-7 wt.%).

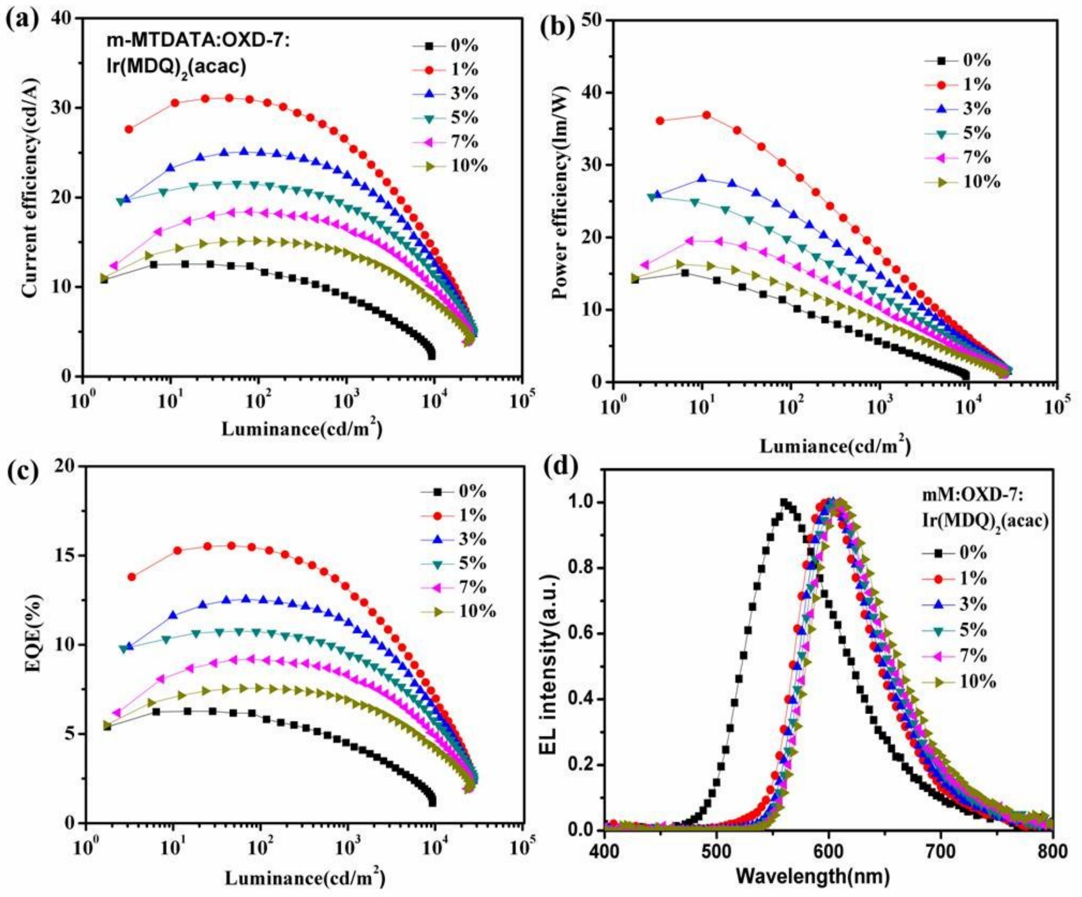


Figure S3. (a) CE-L, (b) PE-L, (c) EQE-L and (d) EL spectra of Device A series doped with different $Ir(MDQ)_2acac$ concentrations.

Table S1. Summary of EL performance parameters of Device A series doped with varied $Ir(MDQ)_2acac$ concentrations.

m-MTDATA:OXD-7: $Ir(MDQ)_2(acac)$	$V_{turn-on}$ (V)	L_{Max} (cd/m^2)	CE_{Max} (cd/A)	PE_{Max} (lm/W)	EQE(%)
0%	2.4	9407	12.5	15.1	5.8
1%	2.4	26385	31.1	36.9	15.5
3%	2.4	27332	25.1	28.1	12.5
5%	2.4	27821	21.5	25.6	10.7
7%	2.4	25950	18.4	19.5	9.2
10%	2.4	25333	15.1	16.3	7.6

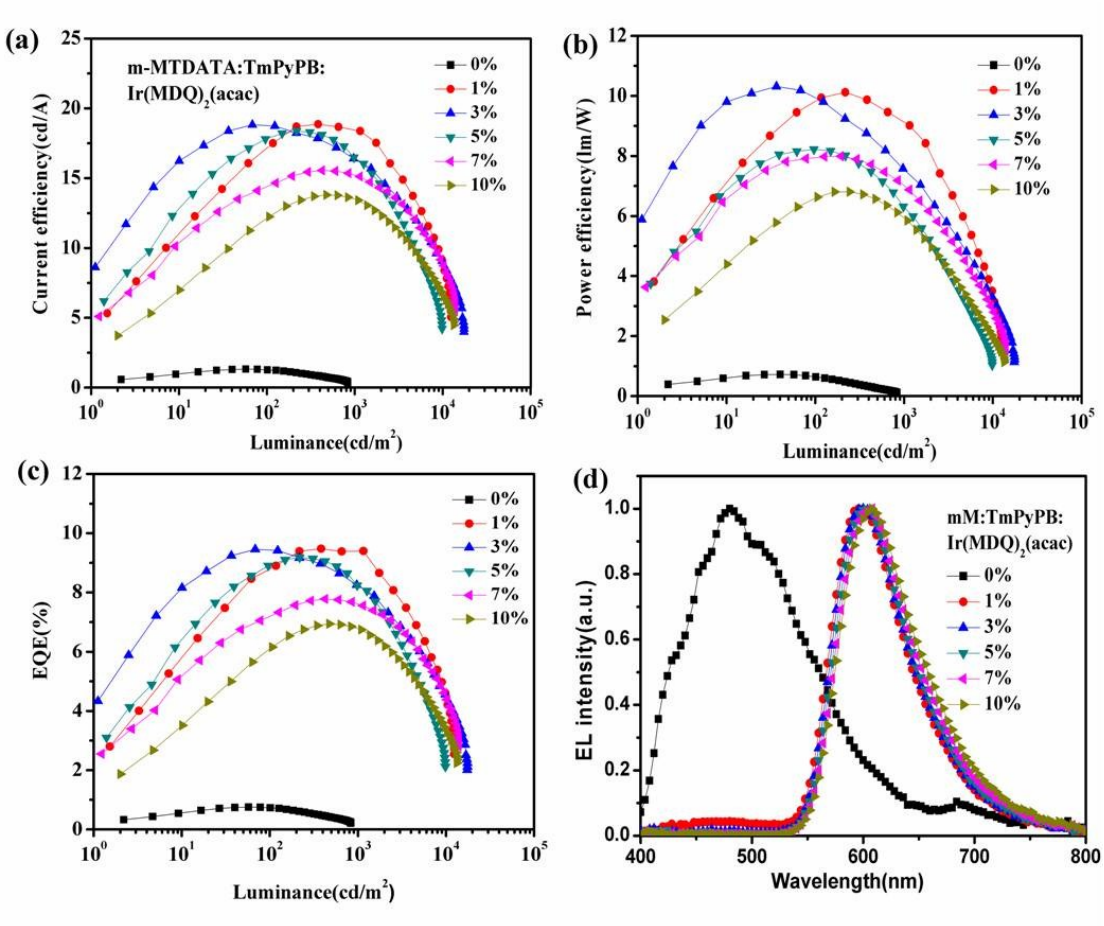


Figure S4. (a) CE-L, (b) PE-L, (c) EQE-L and (d) EL spectra of Device B series doped with varied $Ir(MDQ)_2acac$ concentrations.

Table S2. Summary of EL performance parameters of Device B series $Ir(MDQ)_2acac$ concentrations.

m-MTDATA:TmPyPB: $Ir(MDQ)_2(acac)$	$V_{turn-on}$ (V)	$Luminance_{Max}$ (cd/m^2)	CE_{Max} (cd/A)	PE_{Max} (lm/W)	EQE(%)
0%	4.6	834	1.3	0.71	0.75
1%	4.4	12487	18.9	10.1	9.4
3%	4.6	17600	18.8	10.3	9.5
5%	4.4	10860	18.4	8.2	9.1
7%	4.4	14005	15.6	8.0	7.9
10%	4.6	13400	13.8	7.0	7.0

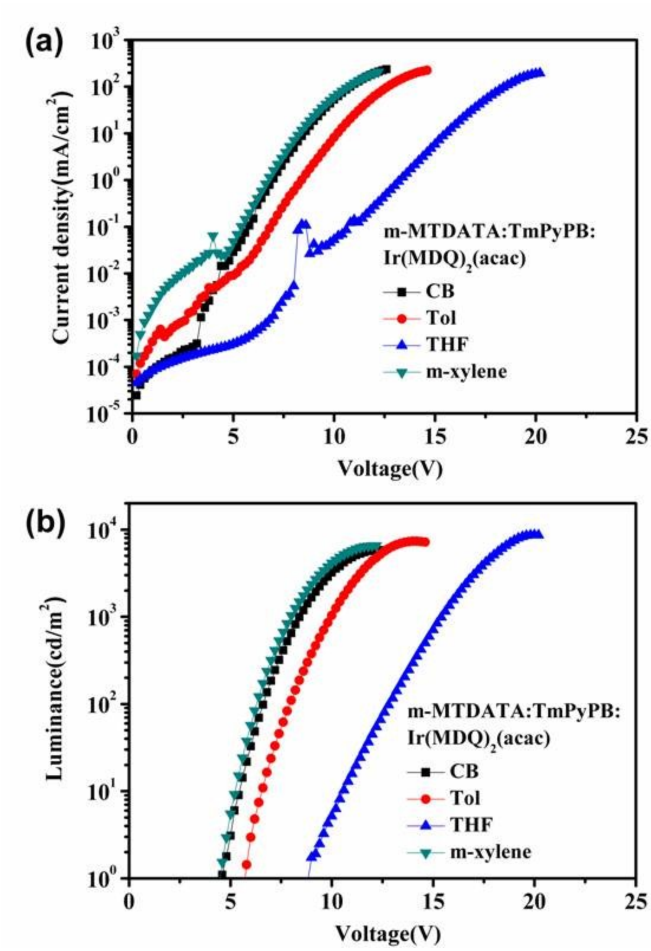
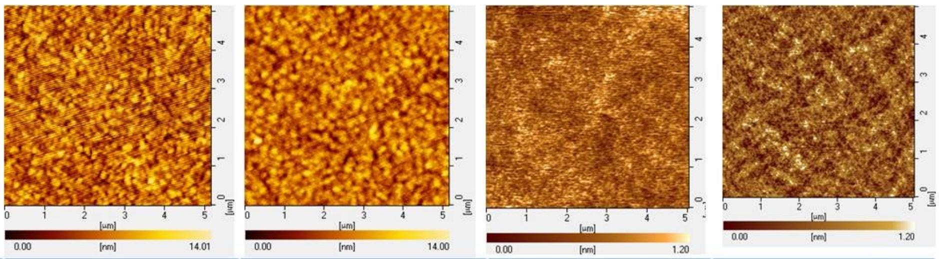


Figure S5. (a) J-V, (b) L-V characteristics of s-PhOLEDs using m-MTDATA:TmPyPB:Ir(MDQ)2(acac) (1 wt.%) as the emissive layer with different dissolution solvent.

As is shown, for device B, the application of different dissolution solvents cannot solves the high driving voltage issues. The unwelcomed thermodynamic miscibility between m-MTDATA and TmPyPB thus intrinsically limits the corresponding EL performance of the s-PhOLEDs.



Sample	m-MTDATA:OXD-7 (1:1, TE)	m-MTDATA:TmPyPB (1:1, TE)	m-MTDATA:OXD-7 (1:1, SP)	m-MTDATA:TmPyPB (1:1, SP)
RMS roughness (nm)	**2.31**	**1.72**	**0.20**	**0.25**

Figure S6. AFM morphologies of different binary host films via thermal evaporation (TE) or spin-coating (SP) fabrication methods.

As is shown, both thermal-evaporated samples of m-MTDATA:OXD-7 and m-MTDATA:TmPyPB binary host films are similar and feature in relative large RMS roughness. In contrast, both solution-processed samples of m-MTDATA:OXD-7 and m-MTDATA:TmPyPB binary host films are also similar and feature in overall homogeneous morphologies and relative low RMS roughness. Therefore, it seems that there is no direct correlation between apparent morphologies and the resultant device performance of these binary host systems shown in the main text. As we believe, the intrinsic thermodynamic miscibility estimated by interfacial energy calculations plays the key roles and well distinguishes them.