Supporting Information

An Exciplex Host for Deep-Blue Phosphorescent Organic Light-Emitting Diodes

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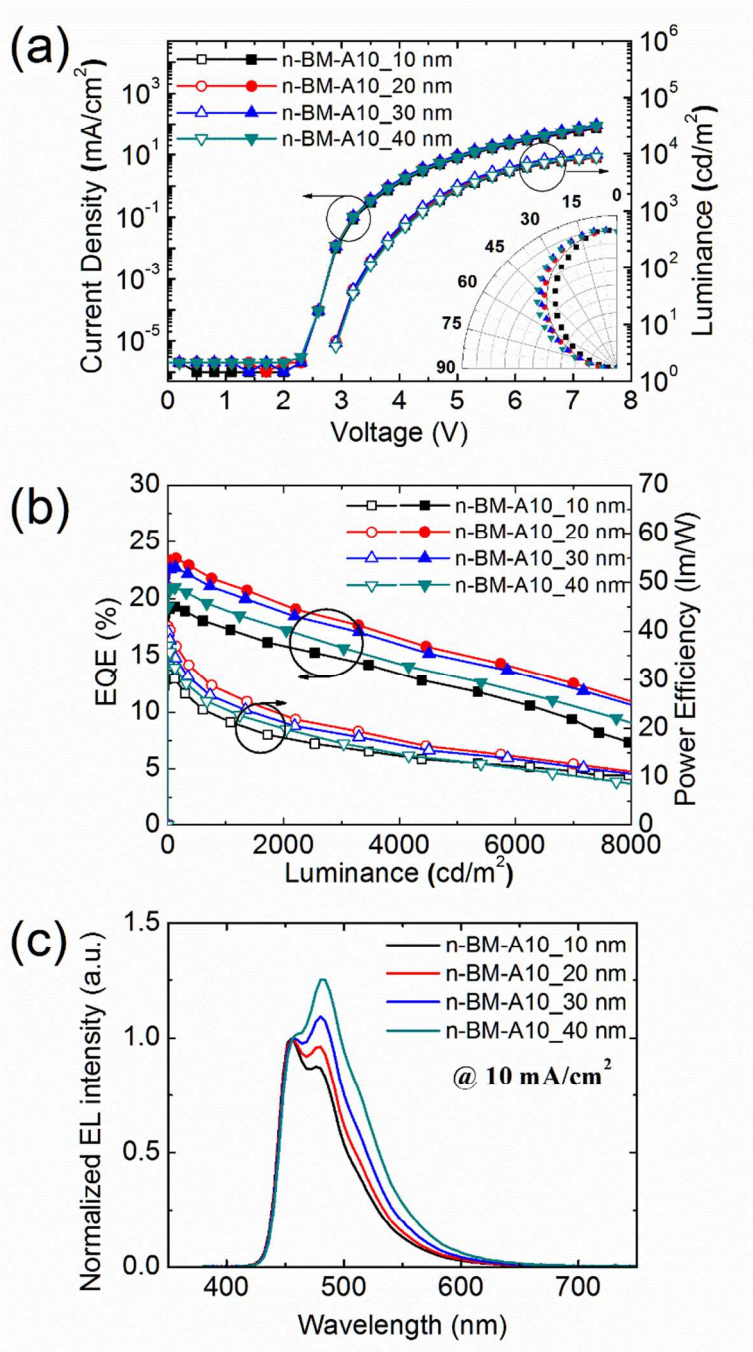

Figure S1. (a) *J–V–L* characteristics of the devices. (b) The EQEs and PEs of the devices. (c) Normalized EL spectra of devices with various thicknesses of the BM-A10 layer.

Figure S1a shows the current density–voltage–luminance (*J–V–L*) characteristics of the devices with the different thicknesses of the electron injection layer. The device structure was

indium tin oxide (ITO) (70 nm)/6 wt% ReO_3 doped mCP (30 nm)/mCP (20 nm)/emitting layer (EML, 30 nm)/BM-A10 (20 nm)/12 wt% Rb_2CO_3 doped BM-A10 (10, 20, 30, 40 nm)/Al (100 nm). The turn-on voltage was 2.9 V. Efficient hole and electron injection was achieved from the electrodes by *p*– and *n*–doping, respectively, and the simple device structure with few interfaces resulted in the low turn-on voltage. Figure S1b shows the Lambertian corrected EQEs and power efficiencies. The emission patterns of the devices were measured via angle-dependent electroluminescence (EL), where the Lambertian correction factors were 0.86, 1.04, 1.06, and 1.14 for *n*–doped BM-A10 layers that were 10-, 20-, 30-, and 40-nm-thick, respectively. Lambertian correction was implemented according to the method reported elsewhere.[1] Figure S1c shows normalized EL spectra of the devices at a current density of 10 mA cm^{-2}. As the thickness of the *n*–BM-A10 layer increased, the intensity of the vibronic peak of FCNIr increased, which is attributed to the microcavity effect.[2] The CIE *y*–coordinate varied from 0.19 to 0.27 as the thickness of the *n*–BM-10 layer increased from 10 to 40 nm. The device with a 10-nm-thick *n*–BM-A10 layer exhibited a maximum EQE of 19% with a power efficiency (PE) of 33 lm W^{-1}. The device with a 20-nm-thick *n*–BM-A10 layer exhibited a maximum EQE of 24% and maximum PE of 41 lm W^{-1} with a CIE *y*–coordinate of 0.21.

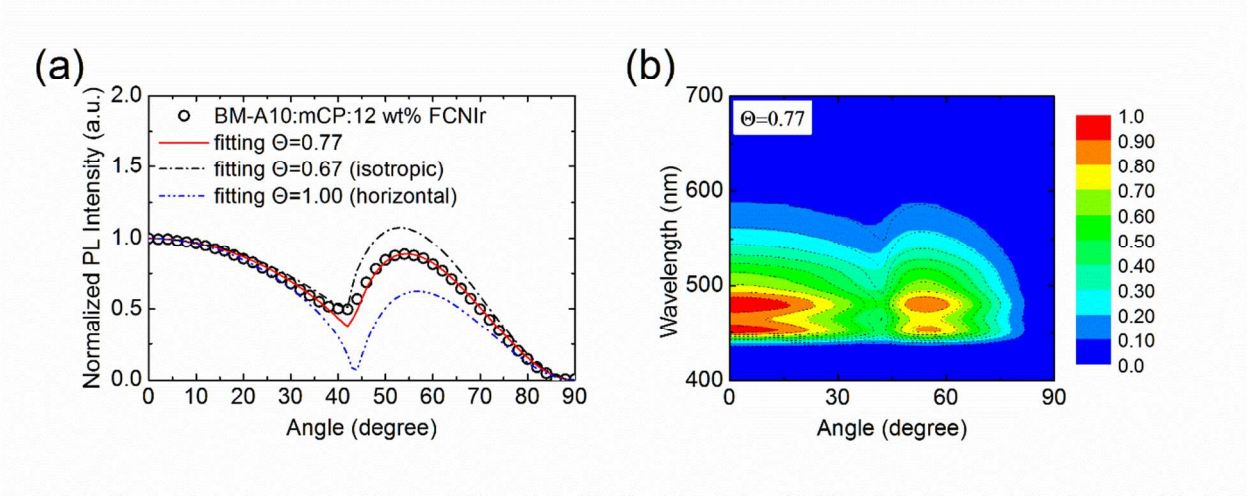

Figure S2. (a) Experimentally obtained angle-dependent PL (open circles) and simulated PL (solid line) of a 30-nm-thick BM-A10:mCP:FCNIr (12wt%) film at 455 nm. (b) Simulated (dashed line) and experimentally obtained (contour plot) angle-dependent PL spectra of an mCP:BM-A10:FCNIr (12 wt%) film.

Table S1. Summarized performances of PhOLEDs with CIE *y*–coordinate close to 0.2.

Host	Dopant	V_{on} [V]	EQE [%][a)]	PE [lm W^{-1}][a)]	CIE (*x*, *y*)	Ref.
mCP: BM-A10 (exciplex)	FCNIr	2.9	24 / 23 / 21	41 / 34 / 23	(0.15, 0.21)	This work
t-DCDPA: DBFTrz (exciplex)	FCNIr	4.0	16.4 / – / 14.7	– / – / –	(0.14, 0.20)	3
pBCb2Cz: TSPO1 (mixed)	tBUCN-FIrmMes	3.0	22.4 / – / 22.4	31.9 / – / 24.9	(0.14, 0.21)	4
TSPO1	*fac*-Ir(pmp)$_3$	4.0	10.1 / – / 9.0	– / – / –	(0.16, 0.09)	5
TSPO1	*mer*-Ir(pmp)$_3$	3.0	14.4 / – / 13.3	– / – / –	(0.16, 0.15)	5
BCPO	(fpmi)$_2$Ir (dmpypz)	3.2	17.1 / 16.5 / 15.1	19.8 / 15.0 / 11.2	(0.13, 0.16)	6
PPO2	FCNIr	–	18.4 / 13.5 / –	16.6 /9.1 / –	(0.14, 0.15)	7
PPO21	FCNIr	3.5	20.4 / – / 11.9	26.1 / – / 6.6	(0.14, 0.19)	8
PO9	Ir(dbfmi)	2.6	18.6 / 13.6 / 6.2	35.9 / 19.6 / 6.3	(0.15, 0.19)	9
mCP	(dfpypy)$_2$ Ir(dpm)	3.5	20.4 / 20.4 / 18.5	24.7 / – / –	(0.14, 0.18)	10
mCPPO1	FCNIrpic	3.5	25.1 / 24.8 / 23.1	21.5 / 21.5 / 15.1	(0.14, 0.18)	11

[a)] Data were measured at the maximum value/100 cd m^{-2}/1000 cd m^{-2}

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