Supplementary Information

Correlation between Small-molecule Dependent Nanomorphology and Device Performance of Organic Light-Emitting Diodes with Ternary Blend Emitting Layer

Odongo Francis Ngome Okello[1],Young-Tae Kim[1,], Hyeon-Dong Lee[1],*

Young-Hoon Kim[2], Tae-Woo Lee[2,3,4], and Chan-Gyung Park[1,5,]*

[1]Department of Material Science and Engineering, Pohang University of Science and Technology (POSTECH), Pohang 790-784, South Korea

[2]Research Institute of Advanced Materials, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Republic of Korea

[3]BK21PLUS SNU Materials Division for Education Creative Global Leaders, Seoul National University, 1 Gwana-ro, Gwanak-gu, Seoul 08826, Republic of Korea

[4]Department of Material Science and Engineering, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Republic of Korea

[5]National Institute for Nanomaterials Technology (NINT), Pohang University of Science and Technology (POSTECH), Pohang 790-784, South Korea

[*]Correspondence and requests for materials should be addressed to Y.-T.Kim (email: yt1001@postech.ac.kr) or to C.G.P (email: cgpark1@postech.ac.kr)

Table S1 Physical properties of materials used in the experiment[3]

| Molecule	Chemical Structure	Electronic Property	Band gap (eV)	Homo (eV)	Lumo (eV)	Triplet Energy (eV)	Dipole moment (D)	Molecular weight (g/mol)
CBP		HTM/ETL	3.1	6	2.9	2.6	~0.0	484.89
PBD		ET/HBL	3.8	6.2	2.4	2.6	~	298.34
TCTA		HTM	3.3	5.7	2.4	2.86	3.0	740.89
TPBI		ET/HBL	3.5	6.3	2.8	2.8	3.4	654.76
3TPYMB		ET/HBL	3.5	6.8	3.3	2.87	3.5	599.61
Ir(ppy)$_3$		Dopant	2.6	5.6	3.0	2.4	6.26	654.78
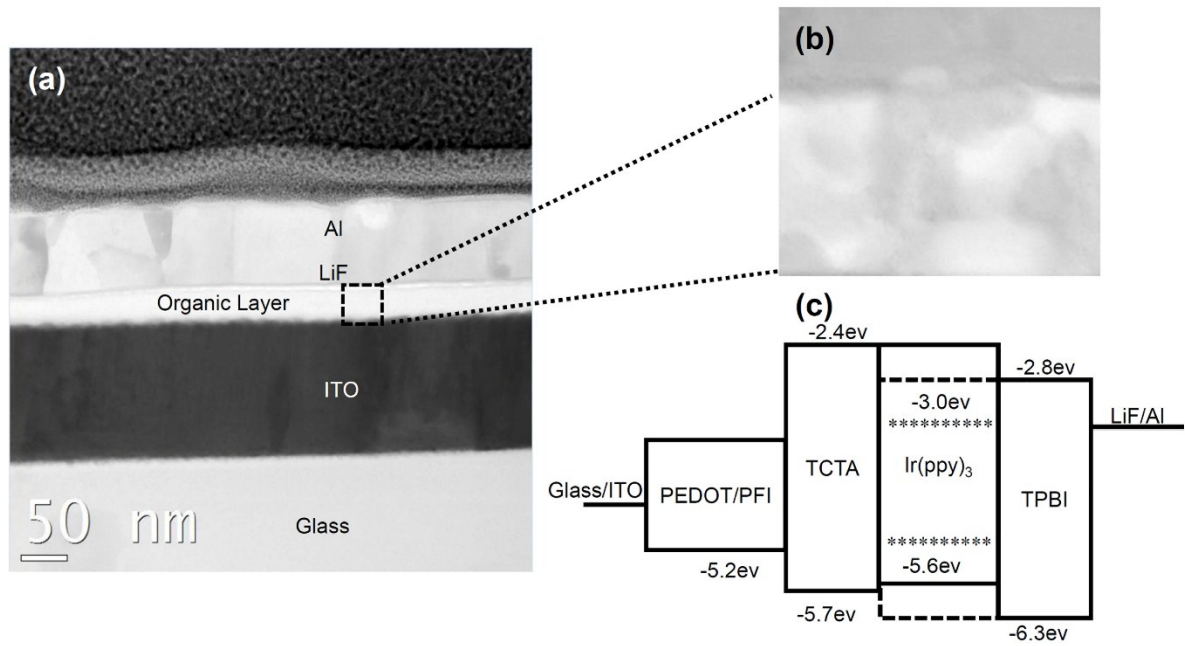
Fig. S1 Shows (a) TEM Cross-sectional image of TCTA:TPBI:Ir(ppy)$_3$ based device structure comprising of PEDOT:PSS:PIF/EML/TPBI/LiF/Al, (b) magnified image of the EML (c) energy band diagram of the green OLED.

**Table S2** Physical properties of solvents in study[57,58]

Solvent Type	Boiling point (C)	Dipole moment (D)	Evaporation rate	Vapor Pressure 20(hPa)	HB $(cal/cm^3)^{1/2}$	HS $(Mpa)^{1/2}$
Dichlorobenzene (DCB)	180	2.27	<1	1.33	10	20.5
Chlorobenzene (CB)	131.7	1.54	1.07	12	9.5	19.6
Toluene(T)	110.6	0.43	6.1	29	8.9	18.2
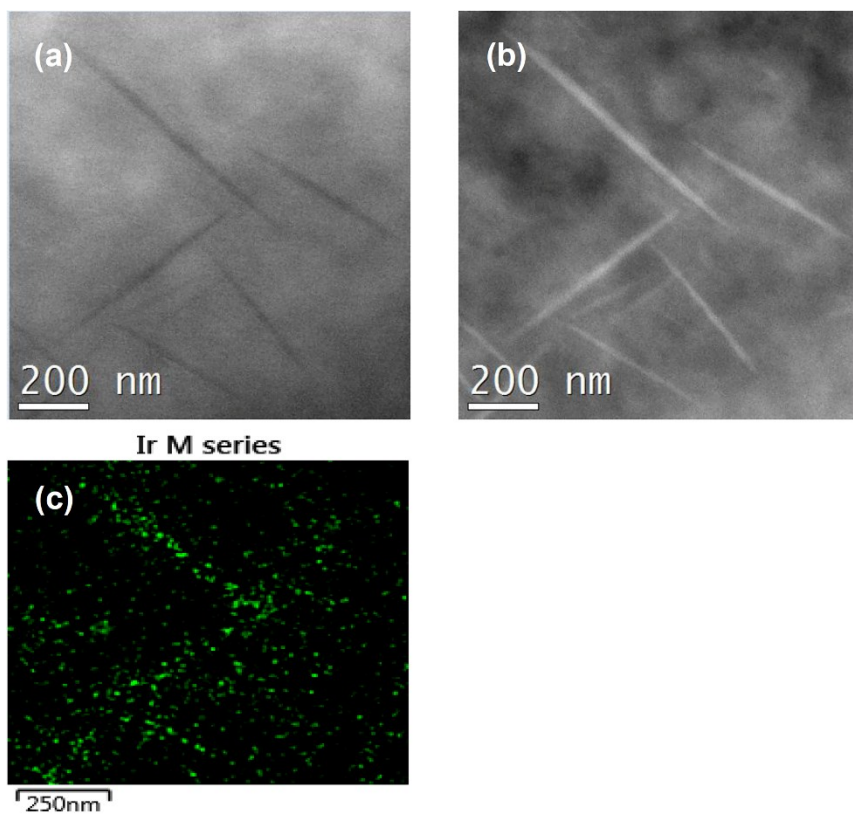
Fig. S2 TEM results: (a) BF image (b) HAADF image and (c) EDS mapping showing the Ir(ppy)$_3$ needle-like aggregate observed in TCTA:TPBI:Ir(ppy)$_3$ ternary blend emitting layer.
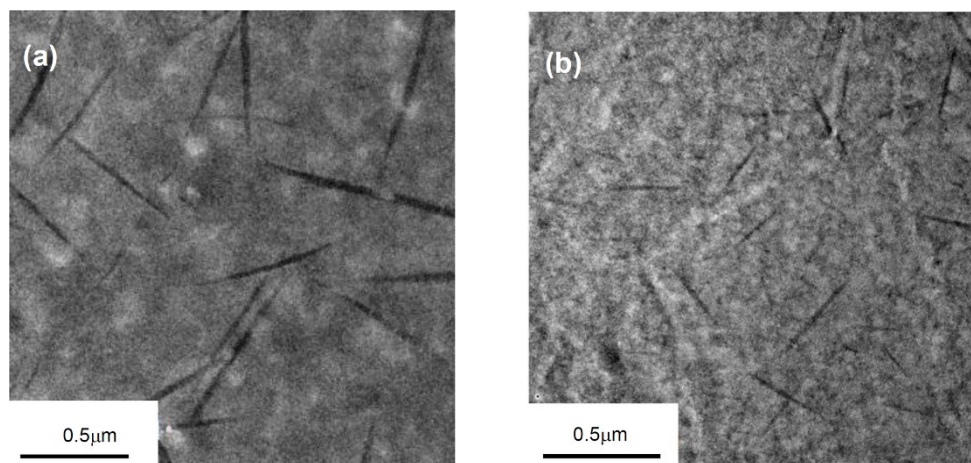
Fig. S3 TEM BF image of (a) polymer-small molecule (PVK:3TPYMB:Ir(ppy)$_3$), and (b) small molecule based (TCTA:3TPYMB:Ir(ppy)$_3$) emitting layer. The ppy)$_3$ needle-like aggregates are more pronounced in the polymer-small molecule based EML compared to small molecule based EML.
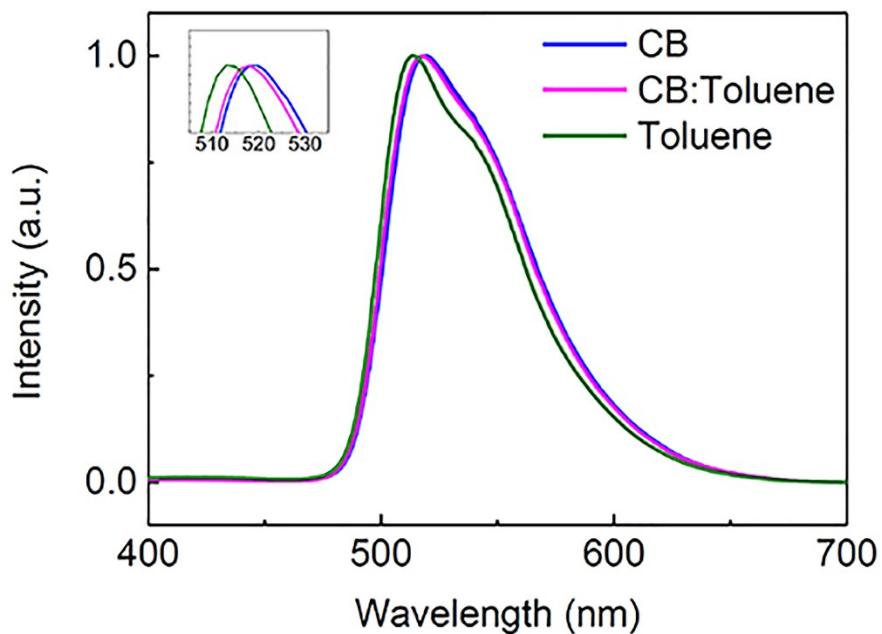
Fig. S4 Steady state Photoluminescence spectra of the TCTA:TPBI:Ir(ppy)$_3$ based EML spin-coated in (a) Chlorobenzene (blue line), (b) 50CB:50T (pink line), and 100T (green line) solvents respectively. The blue-peak shift with increasing ratio of the toluene solvent indicates a decrease in the amount of Ir(ppy)$_3$ aggregates formed in the EML. The magnified inset image on the left is meant for clear observation.