Supporting Information

Synergetic Influences of Mixed-Host Emitting Layer Structures and Hole Injection Layers on Efficiency and Lifetime of Simplified Phosphorescent Organic Light-Emitting Diodes

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SUPPORTING FIGURES AND DESCRIPTION

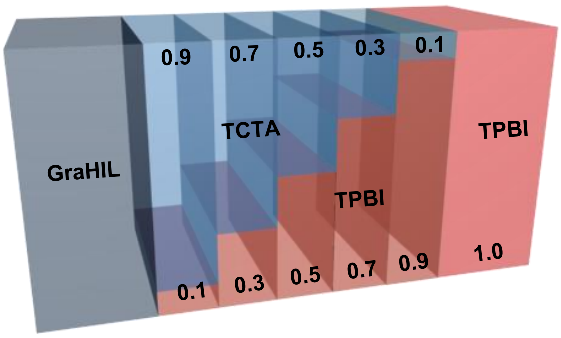

Figure S1. Co-deposition rates of TCTA and TPBI with five individual deposition steps to form the gradient mixed-host emitting layer.

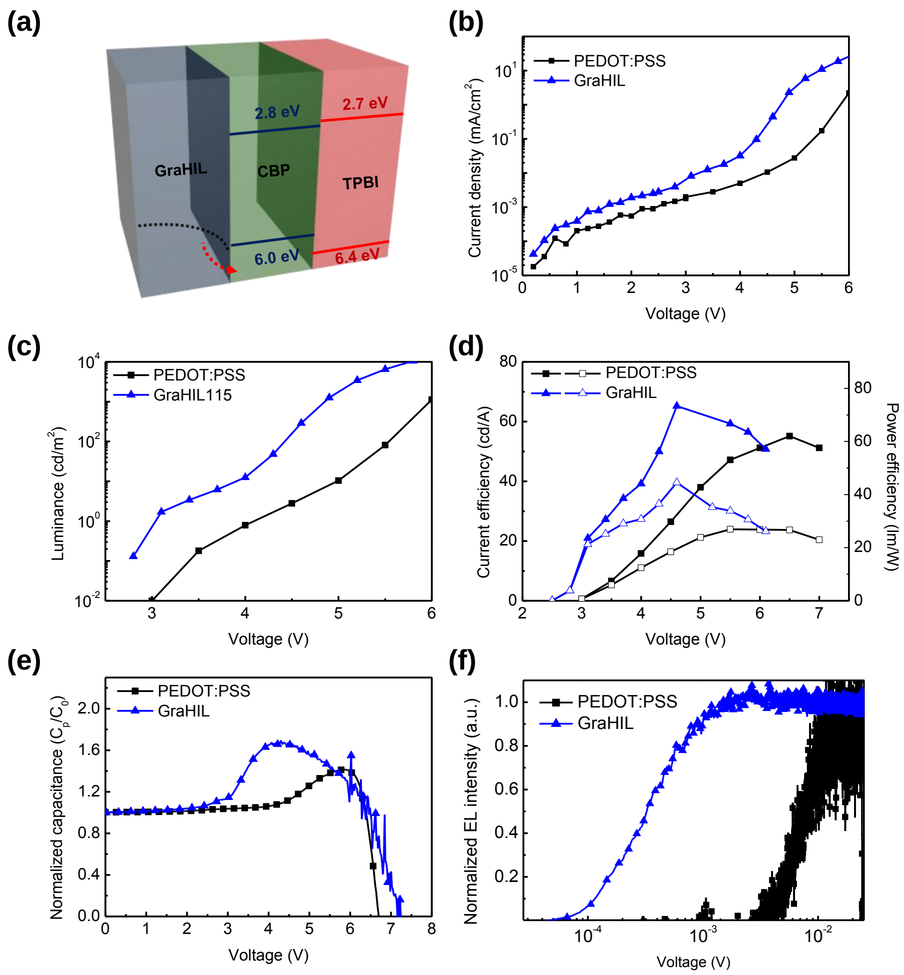

Figure S2. (a) Schematic energy band diagram of HIL, EML, and ETL in simple-structured green phosphorescent OLEDs using a CBP single-host EML, (b) current densities, (c) luminance, (d) current (closed symbols) and power (open symbols) efficiencies, (e) normalized capacitances (C_p C_0^{-1}) versus voltage, (f) transient EL characteristics of simple-structured phosphorescent OLEDs that use a CBP mixed-host EML with GraHIL or PEDOT:PSS as a HIL.

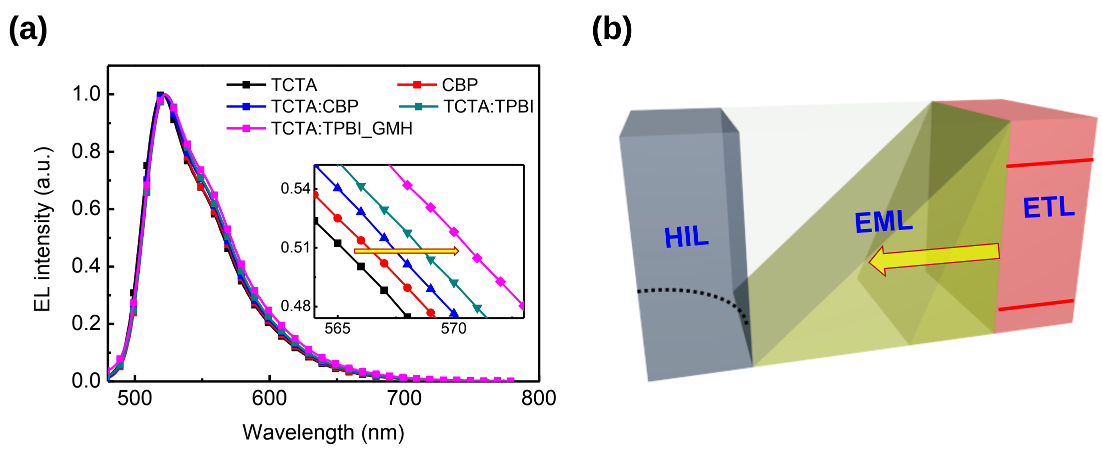

Figure S3. (a) EL spectra of simple-structured green phosphorescent OLEDs that use various kinds of host systems in EML, (b) schematic drawing of recombination zone shift from interface to center of EML.

The expected shifts of recombination zone according to use of various host systems in EML can be evidently demonstrated by comparing electroluminescence (EL) spectra of simple-structured green phosphorescent OLEDs. The red shift of EL spectra according to order of TCTA (unipolar single-host) < CBP (bipolar single-host)< TCTA: CBP (hole dominant mixed-host)< TCTA: TPBI (bipolar mixed-host) < TCTA: TPBI (gradient mixed-host) clearly proves that the recombination zone gradually shifted from emitting layer (EML)/ electron transporting layer interface to the center of EML.[S1]

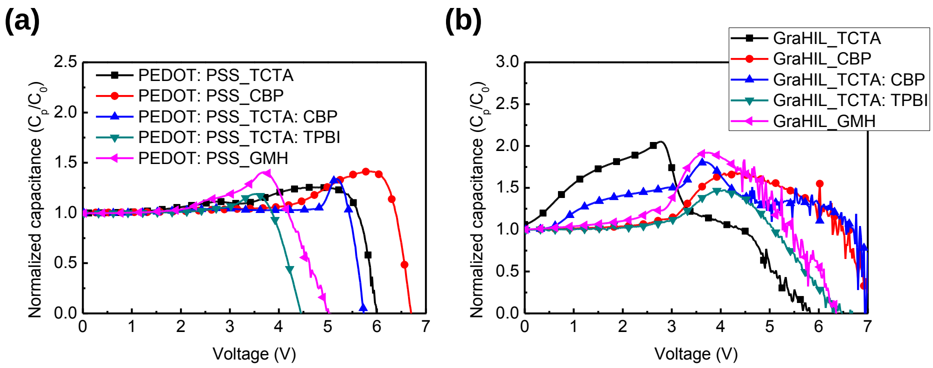

Figure S4. Normalized capacitances (C_p C_0^{-1}) versus voltage of simple-structured OLEDs that use various kinds of host systems in EMLs with a) PEDOT:PSS and b) GraHIL.

Figure S4 shows the comparisons of *C-V* characterizations according to kind of HILs to directly observe influences of host systems in the EML. Because PEDOT: PSS cannot inject major hole carriers well into the EML with TCTA or CBP that has much higher hole mobility than that of electrons due to a large hole injection energy barrier, the use of TCTA: TPBI bipolar mixed-host EML showed remarkable decrease of V_{peak} because of increased electron injection, and gradient mixed-host EML provided further improved electron injection from cathode (faster increase of C_p C_0^{-1} and higher maximum C_p C_0^{-1}) (Figure S4a). High surface work function of the GraHIL greatly improved major hole carrier injection into the EML that uses TCTA or CBP compared to those with PEDOT: PSS (Figure S4b). The use of TCTA: TPBI bipolar mixed-host EML decreased hole accumulation at EML/ ETL interface in low voltage, and electron accumulations in high voltage at HIL/ EML interface respectively resulting in balanced charge injection and transport in EML. Gradient TCTA: TPBI mixed host

EML showed faster increase, higher maximum of $C_p C_0^{-1}$, and lower V_{peak} that mean further improved both hole and electron injection and transport from both electrodes into the EML, and it can form broad recombination zone at the center of EML compared to those with other host systems (Figure S4b).

REFERENCES

S1. Kahen, K. B. Rigorous Optical Modeling of Multilayer Organic Light-Emitting Diode Devices. *Appl. Phys. Lett.* **2001**, *78*, 1649.