Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Highly efficient ultra-flexible tandem organic light-emitting diodes adopting a non-doped charge generation unit

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Materials: Poly(3,4-ethylenedioxythiophene):poly (styrenesulfonic acid) (PEDOT:PSS, AI4083) as hole-injection material was purchased from H. C. Starck Inc. N,N′-di(naphth-1-yl)-N,N′-diphenyl-benzidine (NPB) and 4,4′,4″-tris(N-carbazolyl)-triphenylamine (TCTA) as hole-transporting materials, bis(3,5-difluoro- 2-(2-pyridyl)-phenyl-(2-carboxypyridyl)iridium(III) (FIrPic) as the phosphorescent dopants, 1,3,5-tri(m-pyrid-3-yl-phenyl)-benzene (TmPyPB) as electron transporting material and LiF as electron injection material were provided by the Nichem Fine Technology Co.Ltd. UV curing adhesive NOA63 was purchased from Norland (the USA). In order to ensure the quality of the experimental data, the materials used in this experiment are the purest.

Device Fabrication: First, the silicon wafer was hydrophobic treated. Then, the photoresist (NOA63) was spin-coated on the ITO at 1000 rpm for 30 s. The other functional layers were deposited as above, below the pressure of 6×10^{-4} Pa. During the test, the flexible device was peeled off from the silicon wafer. The exact thickness of each layer was detected and displayed by the crystal oscillator so as to weigh the film formation quality and evaporation time. The organic layer, LiF and Al were evaporated at the rate of 1-2, 0.2-0.3, and 3-5 Å/s, respectively. The active emissive area of the devices was 9 mm^2.

Device Test: The current-voltage-luminescence characteristics were measured by Keithley 2602 source meter. The spectrometer (PR655) was used to detect and analyze the electroluminescence spectra. Capacitance-voltage (C-V) measurements were performed using an impedance analyzer (Wayne Kerr 6505B). All the devices were characterized without encapsulation, and all the measurements were carried out under ambient condition at room temperature. The external quantum efficiency of the device was calculated from luminance, current density, and EL spectra. For the bending test of flexible devices, the test equipment was designed by ourselves. In order to eliminate the influence of the environment on the brightness of the flexible OLEDs, we eliminated the intrinsic attenuation of brightness. After bent a certain number of times, the device brightness under the same voltage was recorded.

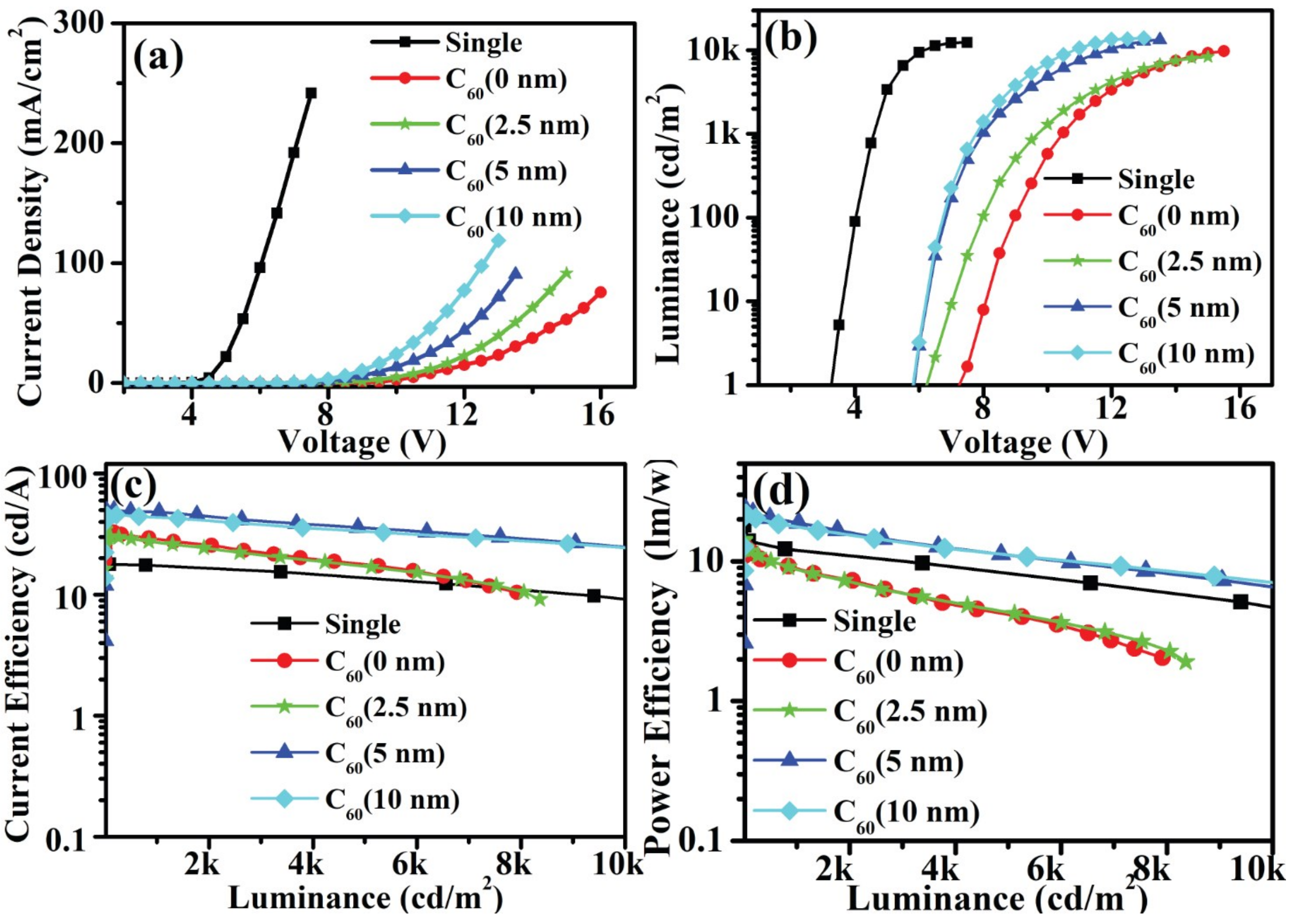

Fig. S1. Characteristics of the single and tandem blue PhOLEDs with different thickness C_{60}: (a) current density-voltage, (b) luminance-voltage, (c) current efficiency-luminance, and (d) power efficiency luminance.

The structure of single blue OLEDs is ITO/ PEDOT:PSS/NPB (40 nm)/TCTA (10 nm)/FIrPic (0.25 nm)/TmPyPB (40 nm)/LiF (1 nm)/Al (100 nm). And the tandem device structure is ITO/PEDOT:PSS/NPB(40 nm)/TCTA(10 nm)/FIrPic(0.25 nm)/TmPyPB(40 nm)/LiF(1 nm)/Al(5 nm)/C_{60}(x nm)HAT-CN(15 nm)/NPB(40 nm)/TCTA(10 nm)/FIrPic(0.25 nm)/TmPyPB(40 nm)/LiF(1 nm)/Al, where x is 0, 2.5, 5, 10.

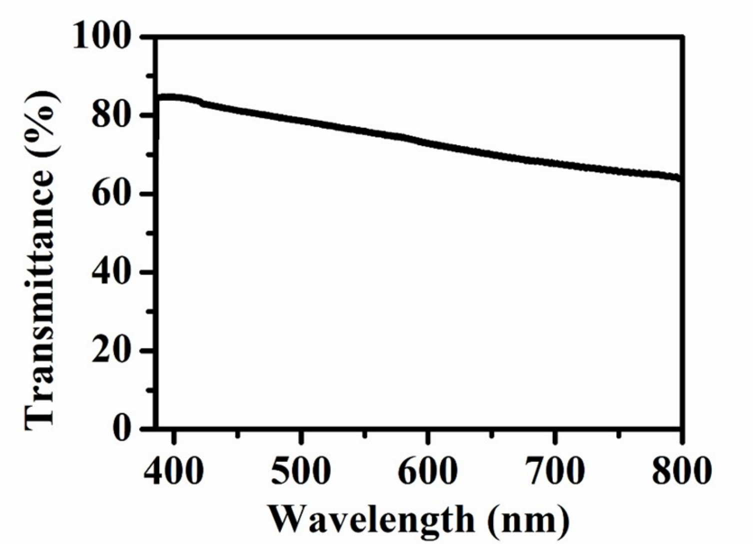

Fig. S2. Optical transmission spectra of MoO_3(3 nm)/Ag(10 nm)/MoO_3(15 nm) transparent anode.

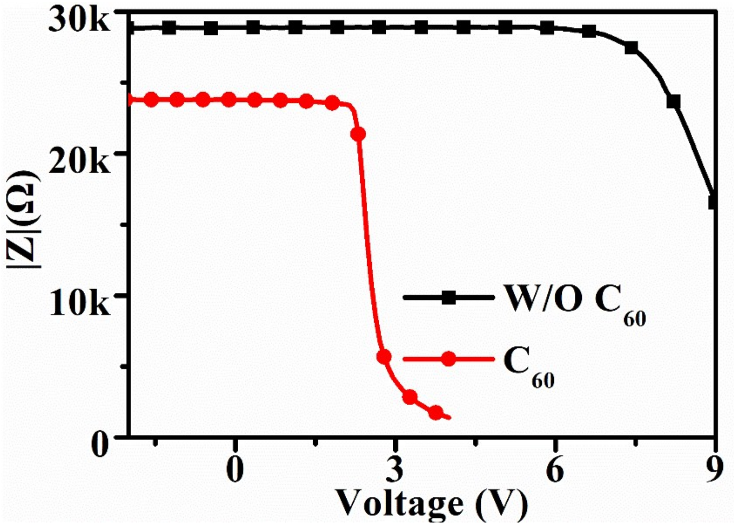

Fig. S3.The impedance versus voltage (Z-V) at 1 kHz and 200 mV AC amplitude.

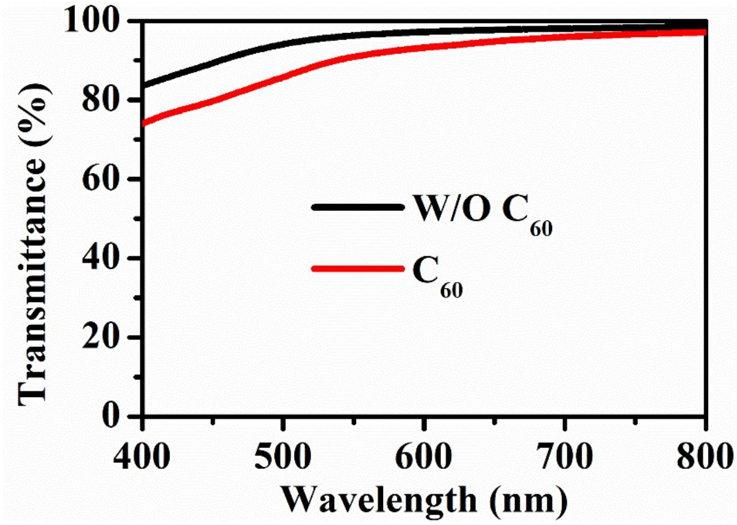

Fig. S4. Optical transmission spectra of CGU of LiF(1 nm)/Al(5 nm)/C_{60}(5 nm)/HAT-CN(15 nm) and LiF(1 nm)/Al(5 nm)/HAT-CN(15 nm).

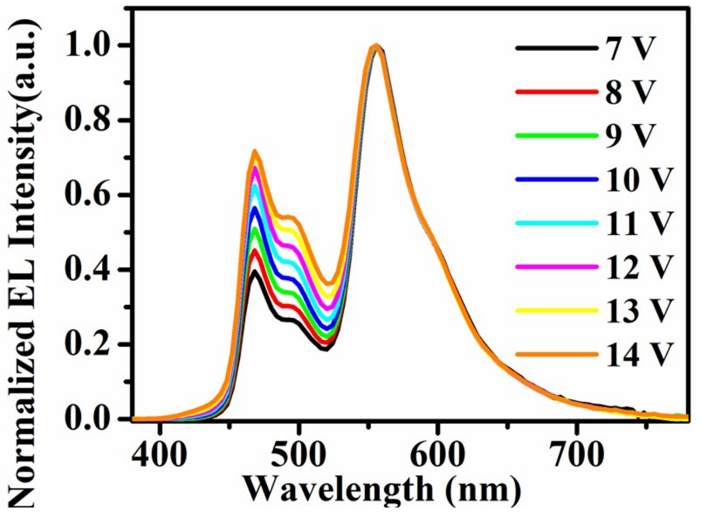

Fig. S5. The EL spectra of the white TOLED with C_{60} layer.