Supplementary Material

Crucial role of quaternary mixture of active layer in organic indoor solar cell

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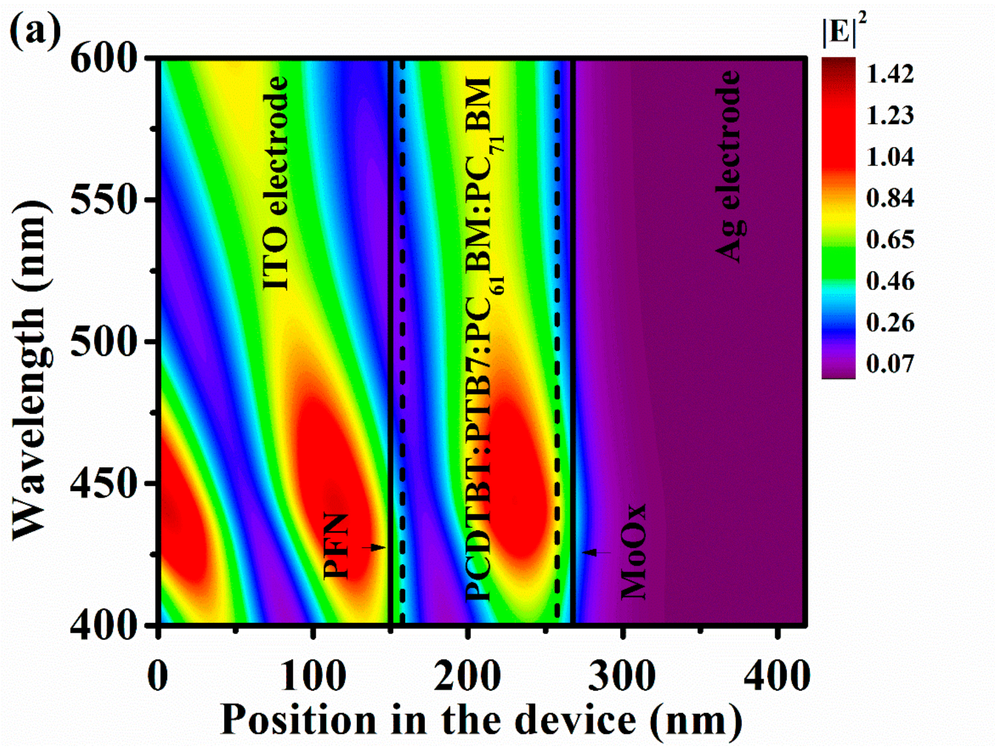
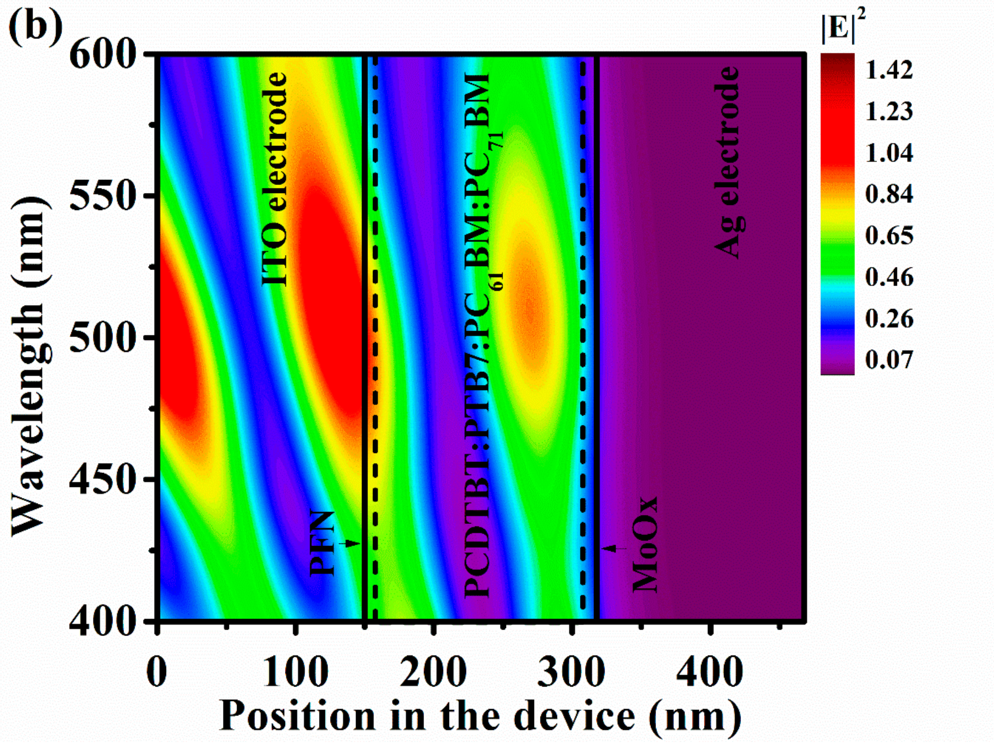
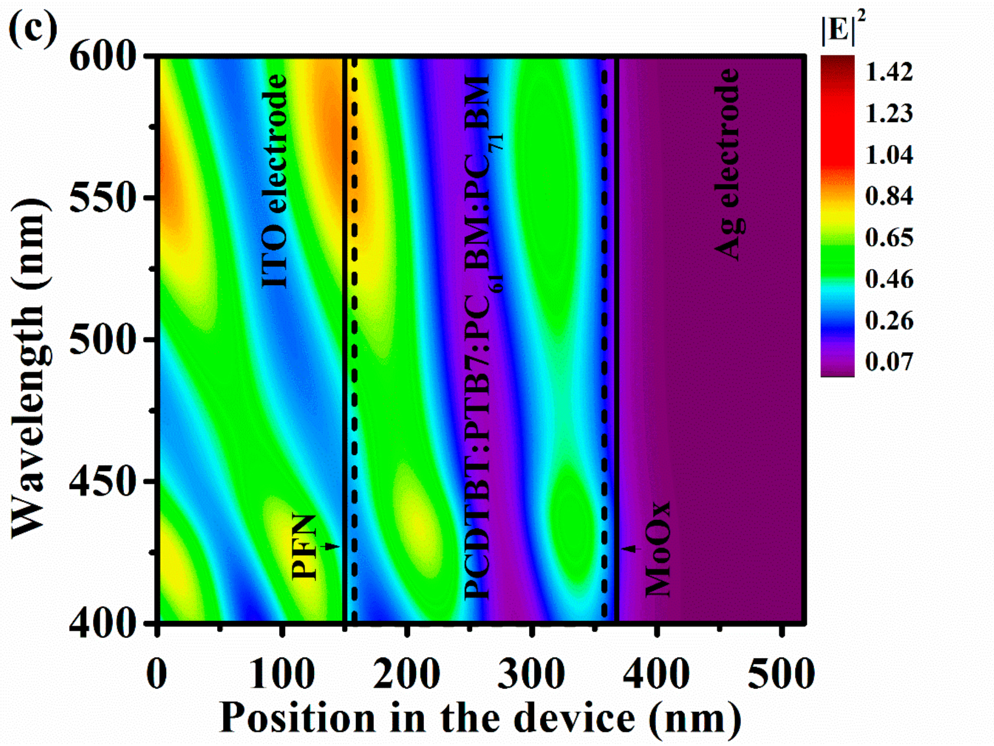


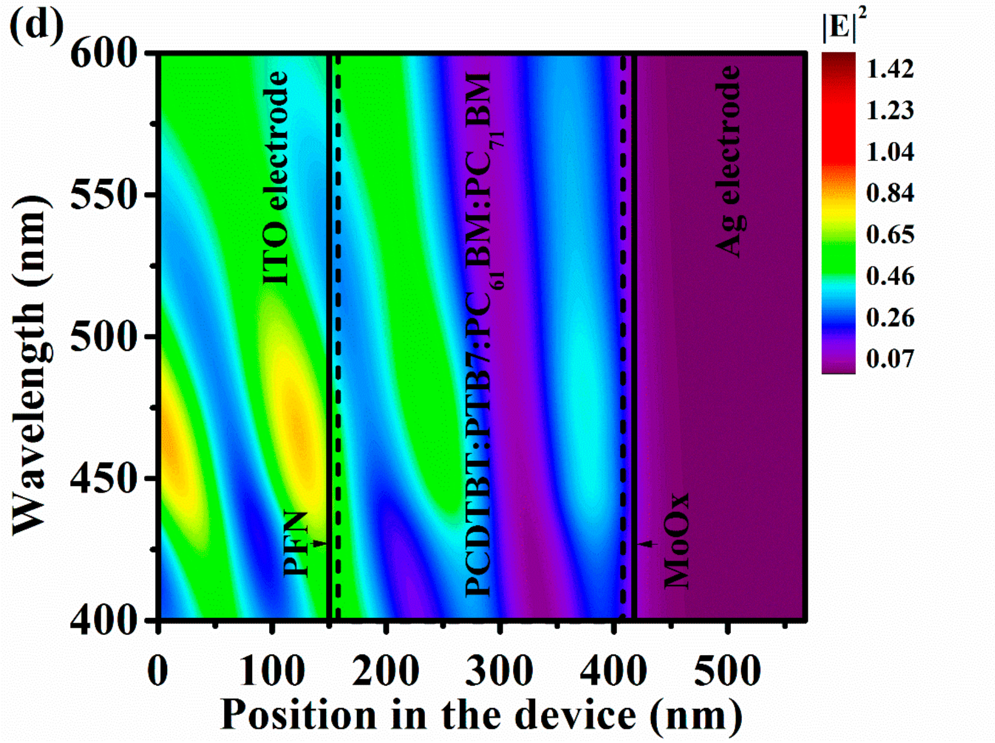
(a)


(b)
|E|^2
1.42
1.23
1.04
0.84
0.65
0.46
0.26
0.07
ITO electrode
PCDTBT:PTB7:PC$_{61}$BM:PC$_{71}$BM
Ag electrode
PFN
MoOx
Wavelength (nm)
Position in the device (nm)

(b)

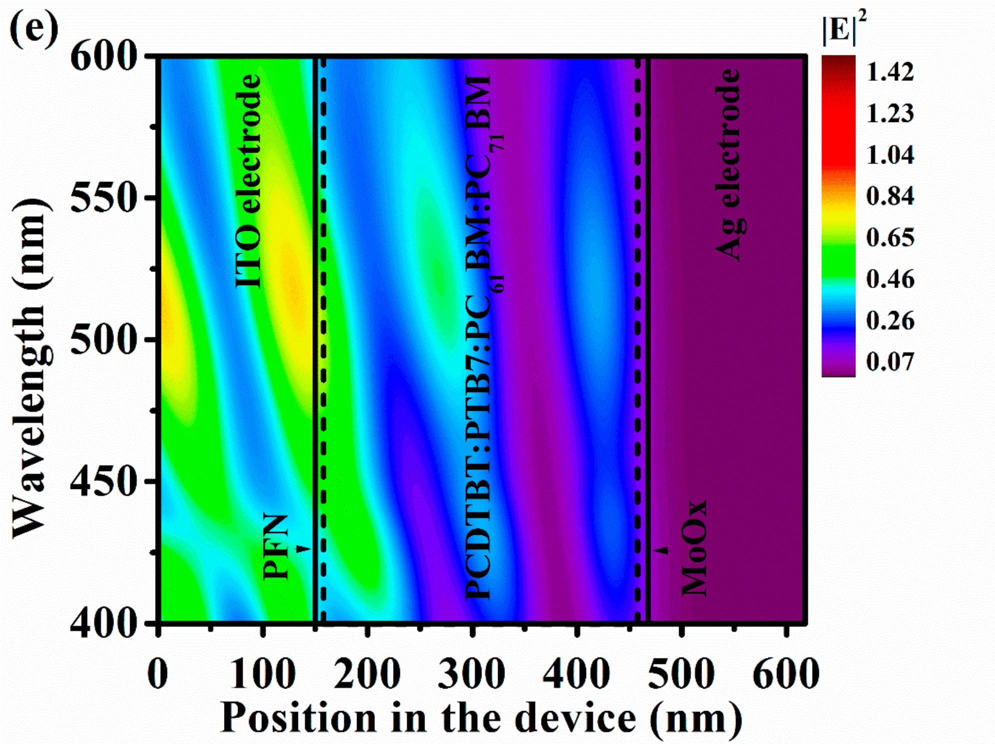

(c)
|E|^2
1.42
1.23
1.04
0.84
0.65
0.46
0.26
0.07
ITO electrode
PCDTBT:PTB7:PC$_{61}$BM:PC$_{71}$BM
Ag electrode
PFN
MoOx
Wavelength (nm)
Position in the device (nm)

(c)



(d)
|E|^2
1.42
1.23
1.04
0.84
0.65
0.46
0.26
0.07
600
550
500
450
400
Wavelength (nm)
0
100
200
300
400
500
Position in the device (nm)
ITO electrode
PCDTBT:PTB7:PC$_{61}$BM:PC$_{71}$BM
Ag electrode
PFN
MoOx

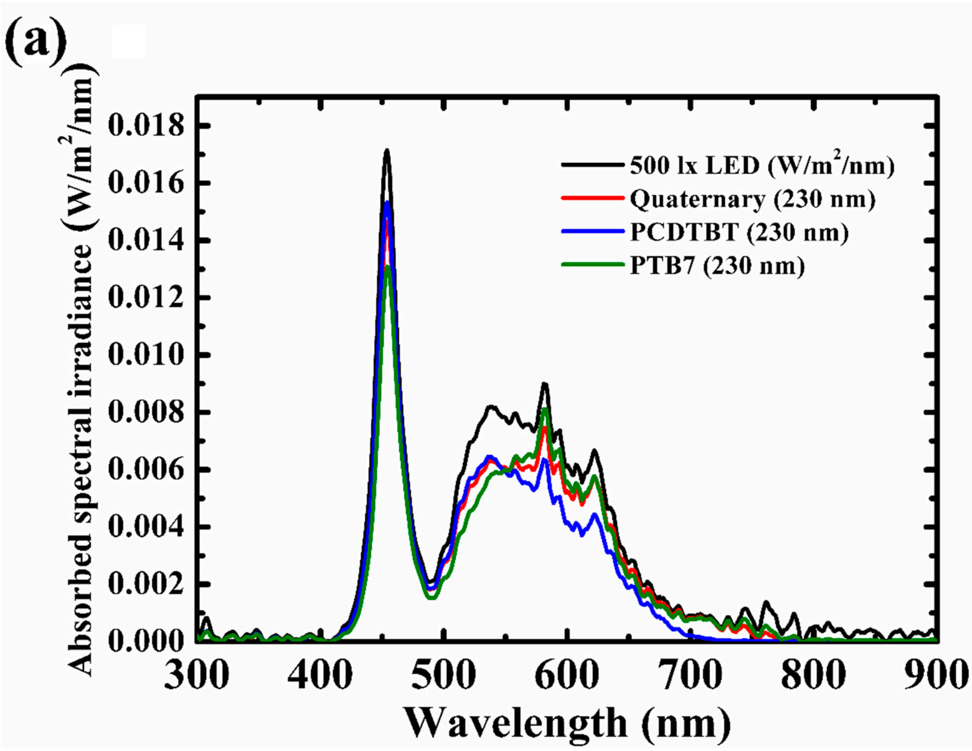
(d)



(e)
|E|^2
1.42
1.23
1.04
0.84
0.65
0.46
0.26
0.07
600
550
500
450
400
Wavelength (nm)
0
100
200
300
400
500
600
Position in the device (nm)
ITO electrode
PCDTBT:PTB7:PC$_{61}$BM:PC$_{71}$BM
Ag electrode
PFN
MoOx

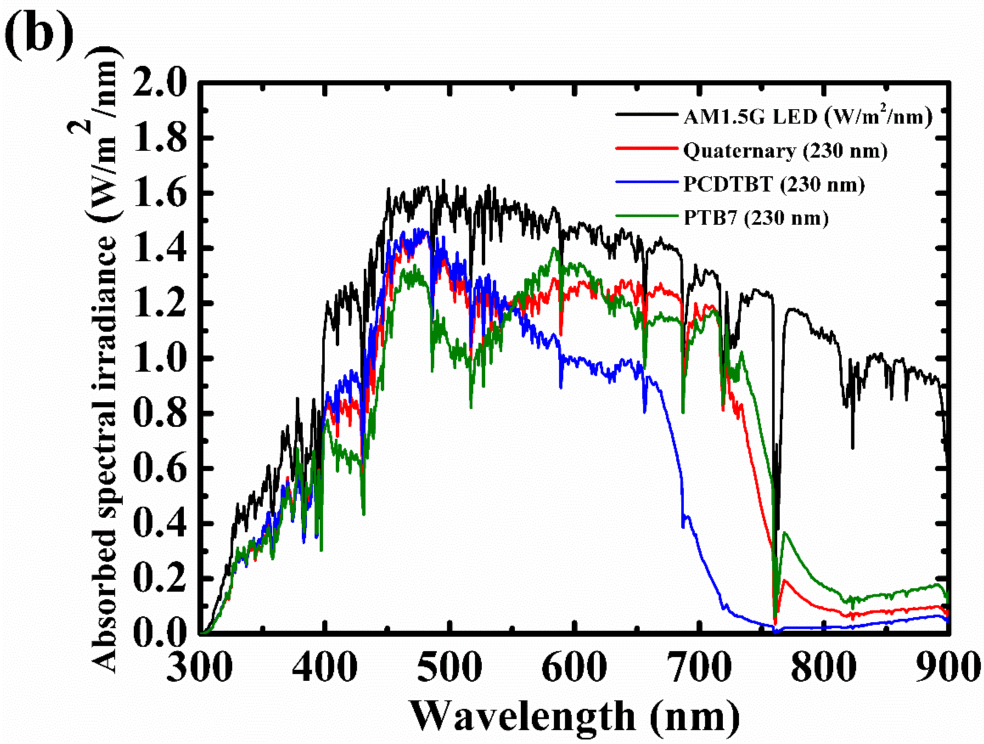
(e)

Figure S1. Electric field intensity distribution in the quaternary photovoltaic: ITO/PFN/PCDTBT:PTB7:PC61BM:PC71BM/MoOx/Ag. (**a**) Active layer thickness = 100 nm. (**b**) Active layer thickness = 150 nm. (**c**) Active layer thickness = 200 nm. (**d**) Active layer thickness = 250 nm. (**e**) Active layer thickness = 300 nm.



v

(**a**)



(**b**)

Figure S2. (**a**) Amount of 500 lx white LED spectrum absorbed by both quaternary and single BHJ photovoltaics. (**b**) Amount of AM1.5 G spectrum absorbed by both quaternary and single BHJ photovoltaics.

Investigation of the Oscillatory Behavior of $J_{sc,ideal}$ in Figure S2a:

Figure S2a shows that Jsc,ideal had higher oscillatory behavior when the photovoltaic cells were illuminated under LED light. We investigated the reason behind this oscillatory behavior in Figures S1a–e, which show the electric field intensity distribution inside the photovoltaic devices. When light traverses through the photovoltaic device it reflects, diffracts, and transmits through the different layers due to the variations in the refractive indices of the layers. Moreover, the Ag electrode reflects all of the light back into the device, thus acting like a mirror. Due to these effects, the incoming and the reflected light waves interact constructively and destructively. These interactions cause hotspots and cold spots inside of the device, where the light is concentrated or depleted. Finite-difference time-domain simulations were used to simulate the hotspots inside of the device for active layer thicknesses of 100, 150, 200, 250, and 300 nm (Figure S1). The LED spectrum (Figure S2a) had maxima at wavelengths of ~450 nm and ~550–600 nm. In Figure S1a, the hotspot was observed at around ~450 nm, which was a maximum in the LED spectrum. Moreover, wavelengths from 400 to 600 nm were concentrated was inside the 100 nm thick active layer of the photovoltaic device. As seen in Figure S1b, when the active layer thickness was 150 nm the hotspot moved to the 500 to 550 nm wavelength range. The LED spectrum was not concentrated in this wavelength range, thus resulting in a dip in $J_{sc,ideal}$ in Figure 2a. Figures S1c,d show considerable absorption in the wavelength regions of 450 to 600 nm. Although both spectra show a cold spot cutting through the active layer, the higher thickness of the active layer helped them to absorb more incoming photons than the previous device structures. Finally, Figure S1e shows very little electric field intensity concentrated inside the active layer (highest at ~525 nm). This consequently led to the second drop in the oscillating Jsc,ideal after it reached its maximum at an active layer thickness of ~230 nm. Thus, it can be concluded that the oscillatory nature seen in Figure 2a was due to the interference of the incident and reflected light traversing through the different refractive index layers of the device.