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Fabrication of color-stable organic light-emitting devices by utilizing incomplete energy transform

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1. Introduction

Since multilayer OLEDs had been demonstrated by Tang and Vanslyke in 1987 [1], organic light-emitting diode has received much attention due to its many advantages, such as high contrast, fast response, self emitting, high brightness, wide view angle, thin form factor, and supports in full color application, etc.

However, among many colors of light source, white light is the most important of all due to the feasibility of backlight for liquid crystal displays and the application to full color technology. therefore, white OLEDs plays an important role in display. The critical issue of the multilayer white organic light-emitting diode is the shift in CIE coordinate with different bias voltage[2].

In this study, we improve the shift in CIE coordinate with different bias voltage by adjusting the dopant percentage of DPVBi:Rubrene. The approach to adjust the percentage will be also discussed.

2. Experimental

Fig.1(a) and Fig.1(b) show the OLED structure and the energy band diagram, respectively. NPB is used as hole-transporting layer. DPVBi is used as blue-emitting(468nm) fluorescence layer and host material. Rubrene is used as orange emitting fluorescence(560nm) and gust material. BCP Alq3 and Al are used as hole blocking layer electron transporting layer and cathode, respectively. All organic materials are deposited in the chamber having a base pressure of ~10^{-7} Torr. In this experiment, we design the three OLEDs and the dopant percentage of DPVBi:Rubrene are 1:0.05 1:0.001 and 1:0.0006, respectively. We will observe the effect of dopant percentage upon the shift in CIE coordinate and EL spectrum. All optical characteristics are measured with PR-650.

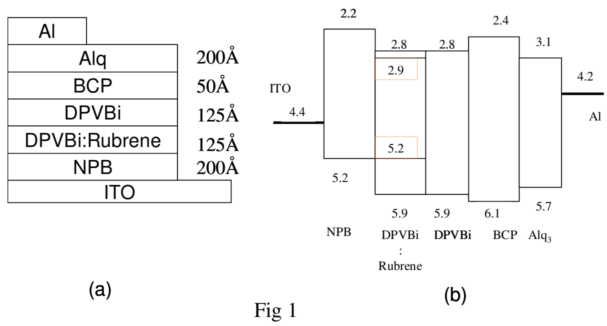

Fig 1

(a) OLED structure in this experiment

(b) The energy band diagram of (a) structure

3. Results and discussion

In this experiment, the EL characteristics are observed from the dopant percentage of DPVBi:Rubrene. Fig.2 shows the EL spectrum of the device(1:0.05) and CIE coordinate is from (0.44 , 0.50) to (0.43 , 0.48) at 6v ~ 11v. As the percentage of DPVBi:Rubrene is 1:0.05, it can be observed that the intensity of 468nm peak is weak and the energy transform from DPVBi to Rubrene is well [3]. Fig.3 depicts the EL spectrum of the device(1:0.01) and CIE coordinate is from (0.38 , 0.47) to (0.35 , 0.42) at 6v~14v. Nevertheless, as we reduce the dopant percentage of

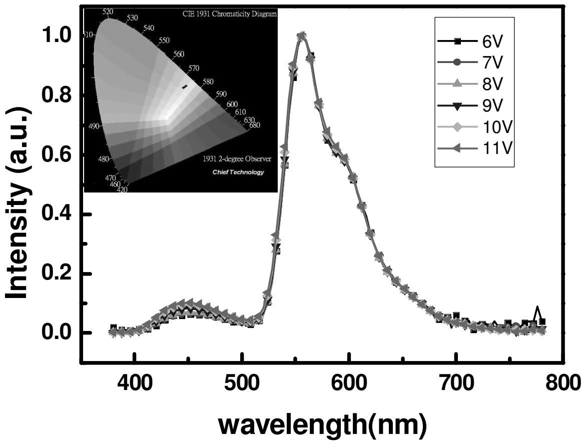

Fig2. EL spectrum and CIE coordinate of device(1:0.05)

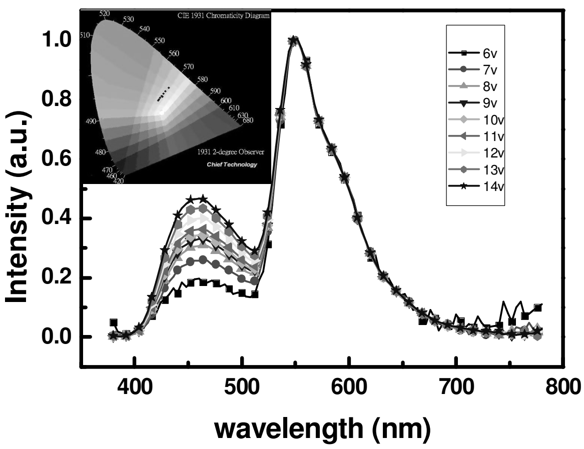

Fig3. EL spectrum and CIE coordinate of device(1:0.01)

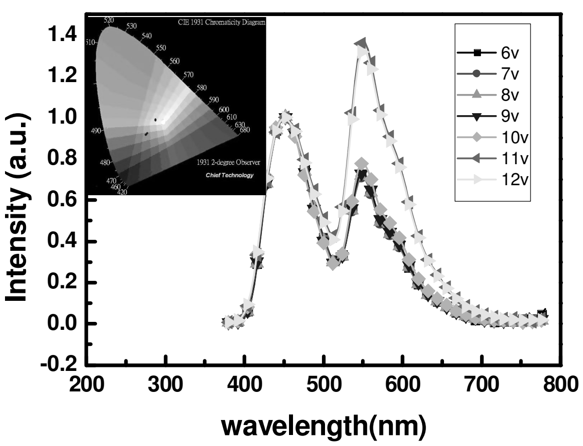

Fig4. EL spectrum and CIE coordinate of device(1:0.006)

DPVBi:Rubrene to 1:0.01, the incomplete energy transform is conspicuous gradually with the increasing bias voltage, thus the hole has enough energy to jump the band gap between NPB and DPVBi. Hence, the intensity of 468nm peak increases with the increasing bias voltage. Fig.4 illustrates the EL spectrum of the device(1:0.006) and CIE coordinate is from (0.25 , 0.27) to (0.31 , 0.35) at 6v~12v. It can be observed that while we reduce the dopant percentage of DPVBi:Rubrene to 1:0.006, the intensity of 560nm peak increases with the increasing bias voltage. However, while the bias voltage exceed 11v, the shift of CIE corrdinate can be no longer observed. The CIE coordinate can not shift with increasing the bias voltage over 11v. We also obtain the luminance is 3833 cd/m2 and CIE coordinate is (0.31 , 0.35) at 11v.

4. Conclusion

In summary, we find that if we control the dopant percentage of DPVBi:Rubrene on 1:0.006, the incomplete energy transform will be conspicuous and that the CIE coordinate can not shift at higher than 11v. We can get the nearest white OLED with 3833 cd/m^2 at 11V, and the stable CIE coordinate (0.31 , 0.35) is quite near the white light region (0.33 , 0.33). Nevertheless, deposition rate is monitored by quartz crystal oscillator, dopant percentage which is lower than 1:0.006 can not been controlled accurately. Hence, if we could search some method to control the lower percentage, we must obtain special effect. It is known that the color of multilayer OLEDs will shift with different bias voltage. Therefore, we can use the incomplete energy transfer by lower dopant percentage to design the color-stable OLEDs.

References

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[3] K. O. Cheon and J. Shinar Appl. Phys. Lett. 84, 1201 (2004)