Si_3N_4 페시베이션 박막이 유기발광다이오드 소자에 주는 영향 연구

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The Study of Silicon Nitride Passivation Layer on OLED

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Abstract : In this paper, we have deposited silicon nitride films by plasma-enhanced chemical vapor deposition (PECVD). For films deposited under optimized conditions, the mechanism of plasma-enhanced vapor deposition of silicon nitride is studied by varying process parameters such as rf power, gas ratio, and chamber pressure. It was demonstrated that organic light-emitting diode (OLEDs) were fabricated with the inorganic passivation layer processing. We have been studied the inorganic film encapsulation effect for organic light-emitting diodes (OLED). To evaluate the passivation layer, we have carried out the fabrication of OLEDs and investigate with luminescence and MOCON.

Key Words : Organic Light-Emitting Diode(OLED), Passivation, Si_3N_4

1. Introduction

In recent years there have been many works in the use of organic materials for electroluminescent (EL) devices based on thin film heterostructure. Organic light emitting diodes (OLEDs) have been widely investigated for their potential applications in high efficiency, high brightness and their potential applications in flat-panel displays. However, the performance of OLEDs is degraded significantly by water vapor adsorption. Therefore, the passivation of OLEDs is necessary to elongate its lifetime by protecting the organic active layer from water-vapor transmission.

On the other hand, PE-CVD(Plasma-enhanced chemical vapor deposition) process is appropriate for mass production in various end-user application, for example, flat-panel displays. In this work, it was demonstrated that OLEDs were fabricated with the passivation layer by PE-CVD processing. the characteristics of the OLED before and after passivation were studied.

2. Experiments

OLEDs were fabricated by the high vacuum thermal evaporation (8×10^{-7} Torr) of organic materials onto the surface of ITO (20 Ω/㎠) coated glass substrate. An ITO coated glass was cleaned in the ultrasonic bath by regular sequence: in acetone, methanol, diluted water and isopropylalcohol. OLEDs with dopant have a configuration of ITO / 2-TNATA (60 nm)/ NPB (20 nm)/ Alq_3:C545T(30 nm:1%) / Alq_3(20 nm) / Liq(2 nm) / Al(150 nm). The Si_3N_4 layers of 500 nm, 1000 nm, 1500 nm thickness were deposited onto the completed OLEDs using PE-CVD, respectively . After that, the OLEDs was stored and measured in ambient air at the average relative humidity of 60 % and temperature of 25 ℃ after deposition of the Si_3N_4 passivation layers.

3. Results and Discussion

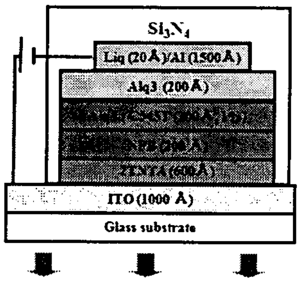

Fig. 1. Schematic diagrams of OLEDs with the Si_3N_4 passivation layer.

Figure 1 shows the structure of OLEDs fabricated with the Si_3N_4 passivation layer. Typical deposition conditions are summarized in Table 1.

Table 1. Si_3N_4 film deposition conditions

SiH_4(sccm)	20
NH_3(sccm)	10
N_2(sccm)	90
Chamber pressure(mtorr)	20
RF power(W)	100~500

layer increases, the WVTR increases up to 0.001 g/m^{2}day.

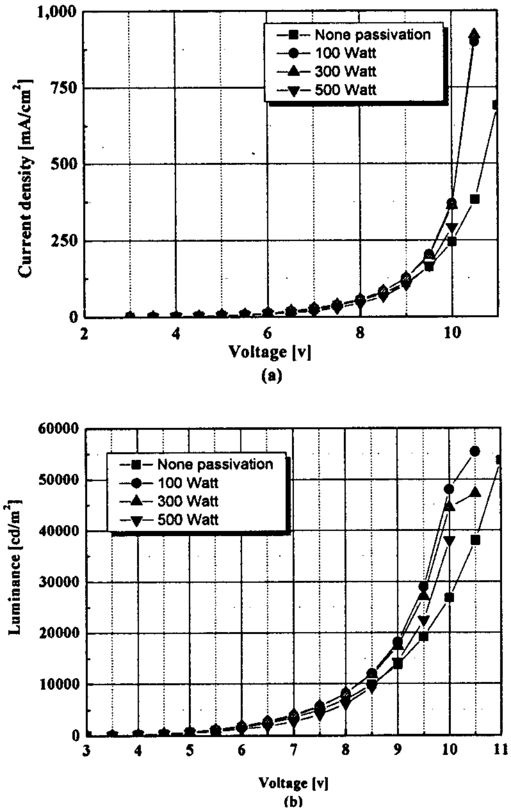

Fig. 2. (a) Current density - voltage and (b) luminance - voltage characteristics of OLEDs before and after applying the passivation process. (RF-power ■None passitvation, ● 100 Watt, ▲300 Watt, ▼500 Watt)

At the same driving voltage, the luminance of the OLEDs with the passivation layer was lower than the luminance of the OLED without the passivation layer, as shown in Figure 2. The passivated device showed very similar luminance characteristics regardless of applied RF-power. After the passivation process, the luminance of the passivated OLEDs was increased by about 10%. This means that the OLEDs stand RF-power up to 500Watt during PECVD process. The WVTR(Water Vapor Transmission Rate) is shown in Figure 3 according to thickness of the Si_3N_4 layer. As the thickness of Si_3N_4 layer increases, the WVTR increases from $\approx$0.1 to 0.001 g/m^{2}day. Figure 4 illustrates the driving test performed on OLEDs with Si_3N_4 passivated and the glass encapsulated OLED are also shown. the initial luminance was 500 cd/m^2 and current was held at the initial value throughout the testing. Operating time increases in proportion to the thickness of Si_3N_4 layer.

4. Conclusion

The devices showed same luminance characteristics regardless of applied RF-power. As the thickness of Si_3N_4 layer increases, the WVTR increases up to 0.001 g/m^{2}day.

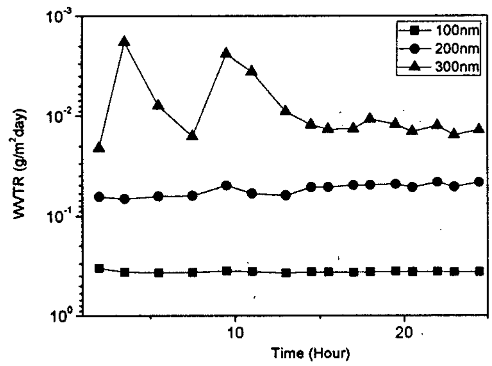

Fig. 3. WVTR data for the barriers deposited on the PET film.(Si_3N_4 thickness ■100 nm, ●200 nm, ▲300 nm)

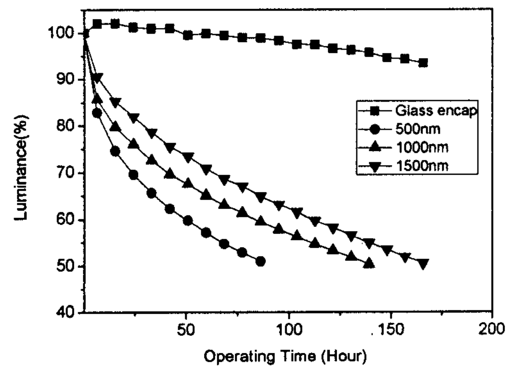

Fig. 4. Typical curves of normalized luminance vs operating time of OLEDs with and without Si_3N_4 passivation measured at initial luminance of 500 cd/m^2 and a constant current density of 0.7mA.(■glass encapsulation, Si_3N_4 Thickness ●500 nm, ▲1000 nm, ▼1500 nm)

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