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We have investigated current-voltage(I-V) characteristics of organic light-emitting diodes based on TPD/Alq_3 organics depending on the application of forward-reverse bias voltage. Luminance-voltage characteristics and luminous efficiency were measured at the same time when the I-V characteristics were measured. We have observed that the I-V characteristics shows a current mxima at low voltage, which is not related to the emission from Alq_3.

Keywords; Organic light-emitting diodes; Current-voltage characteristics

INTRODUCTION

Organic light-emitting diodes (OLEDs) have been received attention due to

potential application to full color flat-panel display. They are attractive because of low-driving voltage and capability of multicolor emission of many synthesized organics[1-2]. The obtained power and quantum efficiency as well as lifetime are already sufficient for commercial application. Nevertheless, the detailed mechanisms on charge carrier injection, transport and recombination are not yet fully understood[4]. In this paper, We present anomalous behavior in the current-voltage characteristics in ITO/TPD/Alq_3/ Al device with a direction of applied voltage.

EXPERIMENTALS

We have used N,N′-diphenyl-N,N′-bis(3-methylphenyl)-1,1′-biphenyl-4,4′-diamine(TPD) as a hole-transport and 8-hydroxyquinoline aluminum(Alq_3) as an electron transport and emissive material. Film thickness of TPD and Alq_3 was made to be around 40nm and 60nm, respectively. Current-voltage characteristics and luminance-voltage characteristics of OLEDs were measured using Keithley 236 source-measure unit, 617 electrometer and Si-photodiode. Luminance-voltage characteristics and luminous efficiency were also measured at the same time when the current-voltage characteristics were measured.

RESULTS AND DISCUSSION

Figure 1 shows the semi-logarithmic plot of current-voltage and luminance-voltage characteristics of ITO/TPD/Alq_3/Al device. The current and luminance were measured as the voltage was increasing from –15V to +15V continuously and then decreasing from +15V to –15V with 100ms delay time at each measurement. Figure 1(a) clearly shows that depending on the direction of applied voltage current follows different paths.

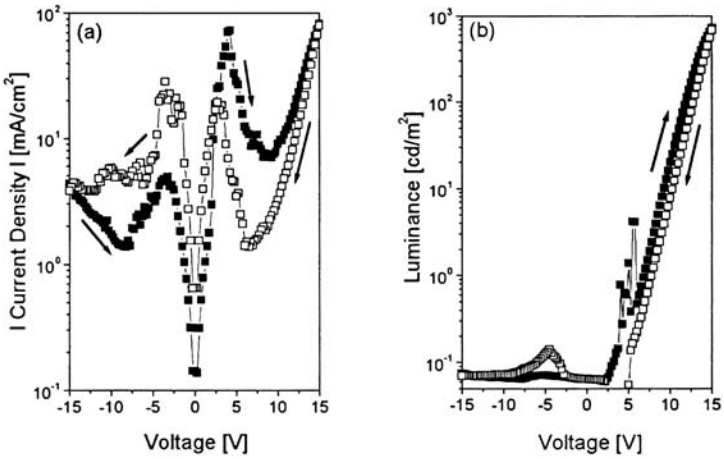

FIGURE 1 (a) Current-voltage characteristics and (b) luminance-voltage characteristics in ITO/TPD/Alq_3/Al device.

There are quasi-reversible current maxima at around ±3.5V and minima at approximately ±8V. Quite surprisingly, there exists negative differential resistance(NDR) region in between 3.5V to 8V. Even though the maximum current at about 3.5V is about the same as that at 15V, the luminance at 3.5V is much lower than that at 15V(see Fig. 1(b)). The luminance in NDR region appears only when the voltage goes either from 0V to –15V or from 0V to +15V.

Figure 2 shows the luminous efficiency and EL spectrum of ITO/TPD/Alq_3/Al device. When the voltage increases above 5V, the variation of efficiency is a little bit steeper than the other way around. Figure 2(b) shows the normalized EL spectrum of device at two different voltages; 3V and 10V. It shows that the emission at 3V is not from Alq_3. In the experiment, we can see that there are some localized spots at low voltage. We don't fully understand it yet where it is originated from.

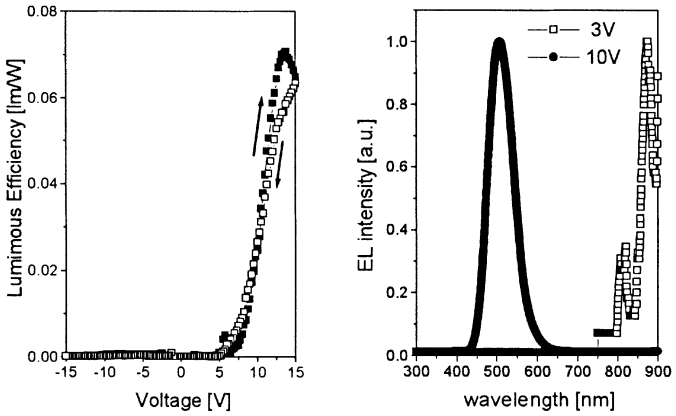

FIGURE 2 (a) Luminous efficiency-voltage characteristics and (b) EL spectrum of ITO/TPD/Alq_3/Al devices.

CONCLUSION

We have observed the anomalous behavior in current-voltage characteristics of ITO/TPD/Alq_3/Al device with the direction of applied voltage. There is a high current at low voltage and there is a NDR region in between 3.5V and 8V. It seems that the conduction mechanism at low voltage is totally different from the one at high voltage.

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References

[1] C.W. Tang, S.A. VanSlyke, C.H. Chen, *J. Appl. Phys.*, **65** (1989) 3610.
[2] C. Hosokawa, H. Higashi, T. Kusumoto, *Appl. Phys. Lett.*, **62** (1996) 3238.
[3] S. Berleb, W. Brutting, M. Schwoerer, *Synth. Metals*, **102** (1999) 1034.