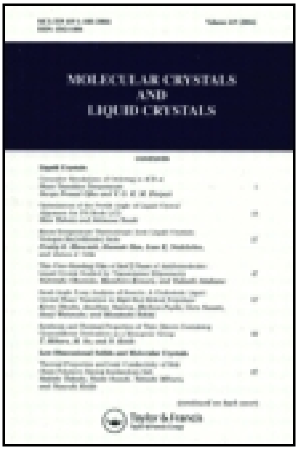

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Hole Block Effect on the Organic Electroluminescent Device using Eu Complex

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The Eu complex, $Eu(TTA)_3(TPPO)$ [tris-(4,4,4-trifluoro-1-(2-thienyl)-butane-1,3-dionate)-triphenyl phosphine oxide europium(III)] is known as the sharp red electroluminescent organic material at the wavelength of 615nm, but its luminance is quite low. In this study, we improved it's electrical and optical characteristics using the hole blocking layer (HBL), BCP [2,9-dimethyl-4,7-diphenyl- 1,10-phenanthroline]. The device with a structure of ITO/TPD/$Eu(TTA)_3(TPPO)$/BCP/Alq_3/Li:Al/Al was fabricated and its photouminescent and electroluminescent characteristics were investigated. It was found that the BCP layer with a thickness of 6nm can block the holes from Eu complex efficiently to improve the EL characteristics of the device. Details on the electrical properties of these structures will be also discussed.

Keywords: Organic electroluminescent devices; Europium complexes; hole blocking layer

INTRODUCTION

Europium (Eu) complex is one of the promising candidate for sharp red emissive materials in OELDs[1,2]. Since Eu complexes emit red light at 615nm from Eu^{3+} ion via an intramolecular energy transfer from the triplet of the organic ligand to the 4f energy state of the Eu^{3+} ion, the theoretical internal quantum efficiency is principally not limited. Sano et al. reported that the luminance of the device using the Eu complex as a dopant was higher than that of the device using the Eu complex as a emitting material. In this study, we improved EL characteristics of Eu complex, $Eu(TTA)_3(TPPO)$ using hole blocking layer, BCP[3]. Electrical and optical characteristics of this Eu complex were investigated.

EXPERIMENTAL

FIGURE 1 shows the molecular structures of the materials and the configurations of the OELDs used in this study, respectively. We fabricated the OELDs of ITO/TPD/$Eu(TTA)_3(TPPO)$/ BCP/ Alq_3/Li:Al/ Al and the OELDs without hole blocking layer, BCP, for comparison.

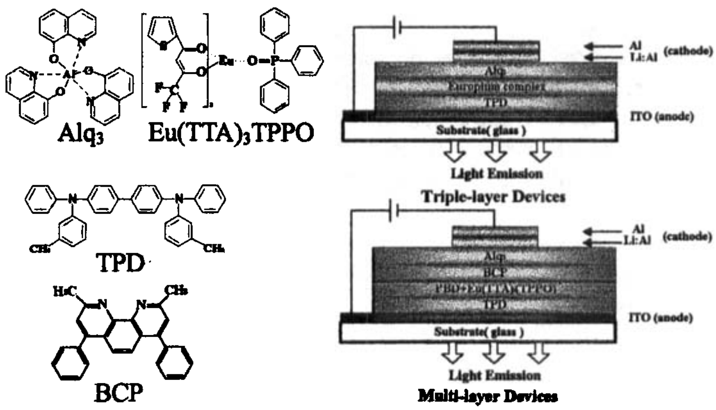


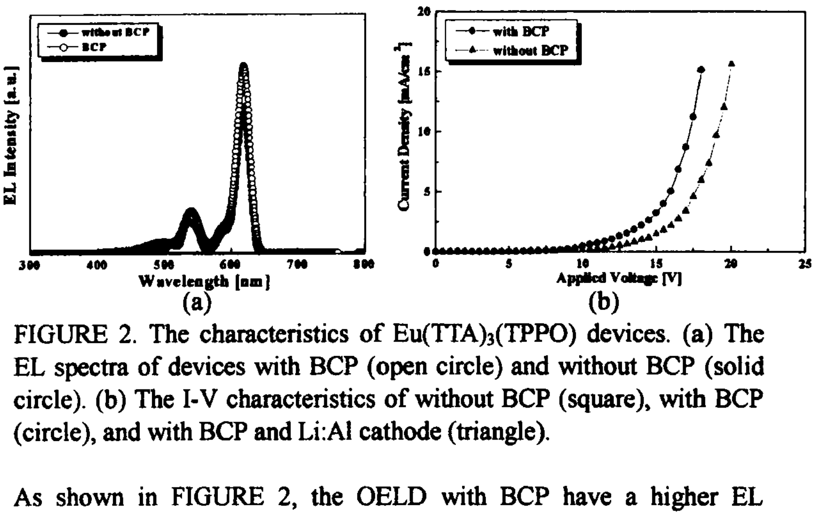
FIGURE 1 The molecular structures of the material and configuration of the OLEDs in this study.

The structure of the multi-layer OELD was a glass substrate/ITO/HTL (TPD = 40 nm)/EML (Eu complex = 10 nm)/ETL (Alq_3 = 40 nm)/HBL

(BCP = 3, 6, 10 nm)/Li:Al (100nm)/Al (100 nm). The organic layers and metal cathodes were successively vacuum deposited onto ITO (indium-tin oxide, sheet resistance : 30Ω/sq) -coated glass substrate at 5 × 10^{-6}Torr. The device area was 25mm^2. All measurements were performed at room temperature in air.

RESULTS AND DISCUSSION

FIGURE 2 shows the characteristics of OELDs. The EL spectra of the OELDs with and without BCP (6nm) are shown in FIGURE 2 (a), and the I-V characteristics are also shown in FIGURE 2 (b).



(a) (b)

FIGURE 2. The characteristics of Eu(TTA)$_3$(TPPO) devices. (a) The EL spectra of devices with BCP (open circle) and without BCP (solid circle). (b) The I-V characteristics of without BCP (square), with BCP (circle), and with BCP and Li:Al cathode (triangle).

As shown in FIGURE 2, the OELD with BCP have a higher EL intensity in the EL spectra at the 18 V and a lower turn-on voltage in the I-V characteristics than those of the OELD without BCP. It was found especially in FIGURE 2 (b) that the current density and luminance of the OELD with BCP was 15 mA/cm^2 and 32.0 cd/m^2, respectively. On the other hand, the current density and luminance of the OELD without BCP was 5.4 mA/cm^2 and 13.3 cd/m^2, respectively. Therefore the power efficiency of OELDs with and without BCP were 0.36 and 0.42 lm/W, respectively. This indicates that BCP blocks the flow of holes from Eu(TTA)$_3$(TPPO) to Alq$_3$ efficiently, which seems to be due to its high ionization potential value (about 6.70 eV). FIGURE 3 also shows the current-voltage characteristics of OELD with various thickness of BCP. It was found in this FIGURE that the current density of OELD with a thickness up to 6nm increases, but the current density of OELD with a thickness of 6nm or higher does not increase. This indicates that the BCP layer with a thickness of 6nm is suitable for the efficient hole blocking layer.

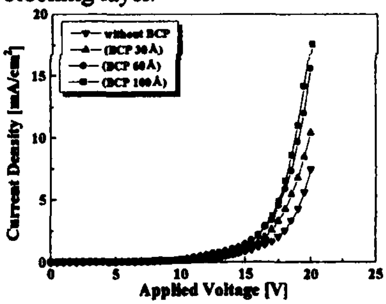


FIGURE 3. The J-V curves with various thickness of BCP.

CONCLUSIONS

The hole blocking layer, BCP, efficiently improved the EL characteristics of $Eu(TTA)_3(TPPO)$ OELDs. The maximum luminance of 32 cd/m^2 and the current density of 15 mA/cm^2 at 18 volts were observed. The optimized BCP thickness was 6nm.

Acknowledgements

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