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Luminescent characteristics of OLED using $Zn(PQ)_2$ as Electron transporting layer and Hole blocking Layer

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1. Introduction

Electroluminescent (EL) devices based on organic thin films are similar to semiconductor base light-emitting diodes in that they were also considered to be one of the next generation flat-panel displays [1]. They are attractive for the in low-operating voltage, low power consumption, ease of fabrication and low cost. Organic metal complexes have attracted much attention because of their potential applications in Organic light emitting diodes (OLEDs) [2,3]. Organic metal complexes have been shown to be particularly useful in OLEDs because of their relatively high stability and volatility. Alq_3 is the most well known example and it has been used as a green emitter or an electron transport material in OLED [4]. Recently, Zn complexes containing 2,6-bis(benzimidazolyl)pyridine (bbp) ligand produce a bright blue emission. Zn complexes with containing new ligands synthesized and used electroluminescence materials [5]. An electron transport layer (ETL) and a hole transport layer (HTL) were used to accelerate carrier transport. A hole-blocking layer (HBL) and an electron-blocking layer(EBL) were also inserted between the ETL and the emission layer (EML), or between the HTL and the EML to increase exciton recombination. Among the several layers comprising OLED, the luminescence efficiencies of OLED are significantly affected by the existence of ETL and HBL [6].

In this study, we characterized synthesized the $Zn(PQ)_2$. We investigate the characterization, fabrication and performance of OLED based on new obtained materials. We used $Zn(PQ)_2$ as hole blocking layer and electron transporting layer. We confirmed electrical and optical properties dependent on each processing condition by fabricating OLED. Our results suggested that, $Zn(PQ)_2$ has showed better performance as a electron transporting layer than a hole blocking layer

2. Experimental

We used $Zn(PQ)_2$ as hole blocking layer (HBL) and electron transporting layer (ETL). Table 1 shows the device structures. Fig. 2 shows the energy band diagram. In case of device 2, $Zn(PQ)_2$ was used as hole blocking layer and in device 3, it was used as electron transporting layer. The substrates used in this study were glass coated with 1500 Å thick ITO (sheet resistance of 15 Ω/ □). We fabricated the OLED with a use of NPB and Alq_3 as a hole transporting layer and emitting layer, respectively. The organic layers and cathode were evaporated under 6×10^{-6} torr. Deposition rate of the organic layers and cathode were 1 Å/s, 10 Å/s, respectively.

The characteristics of the current density-voltage-luminance and the CIE coordinates were measured with an IVL 300 series (JBS Inc.) [5]. All measurements were performed at room temperature in air.

Table 1. The device structures.

Devices	Structure
Device 1	ITO / NPB / Alq_3 / Al
Device 2	ITO / NPB / $Zn(PQ)_2$ / Alq_3 / Al
Device 3	ITO / NPB / Alq_3 / $Zn(PQ)_2$ / Al

3. Results and Discussion

Fig. 1 shows PL spectrum and the molecular structure of $Zn(PQ)_2$. The PL peak of $Zn(PQ)_2$ was observed at 570 nm. $Zn(PQ)_2$ showed yellow emission.

The IP, EA of $Zn(PQ)_2$ were obtained, 7.1eV, 3.4eV, by cyclic voltammetry, respectively. We made device structure rightly in energy band gap, we used $Zn(PQ)_2$ as hole blocking layer (HBL) and electron transporting layer (ETL).

Fig. 2. shows the energy band diagram. In case of device 2, $Zn(PQ)_2$ was used as hole blocking layer and in device 3, it was used as electron transporting layer.

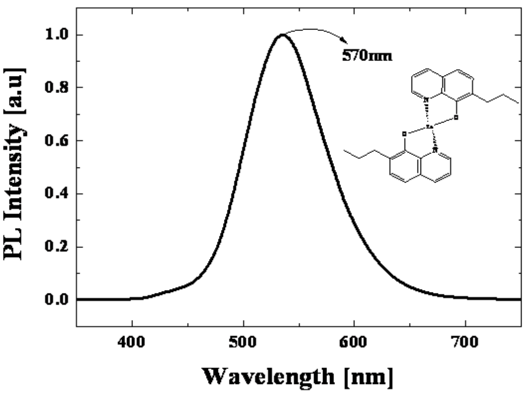


Fig. 1 PL spectrum of $Zn(PQ)_2$

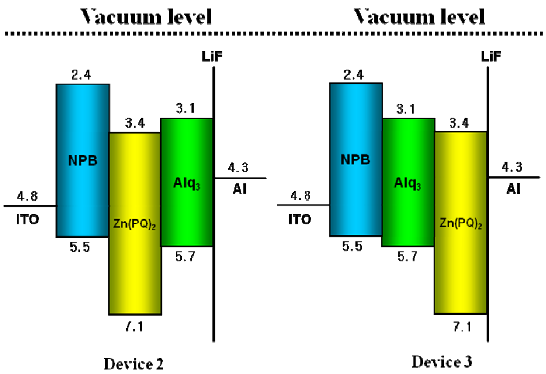


Fig. 2 The energy level alignment of the devices.

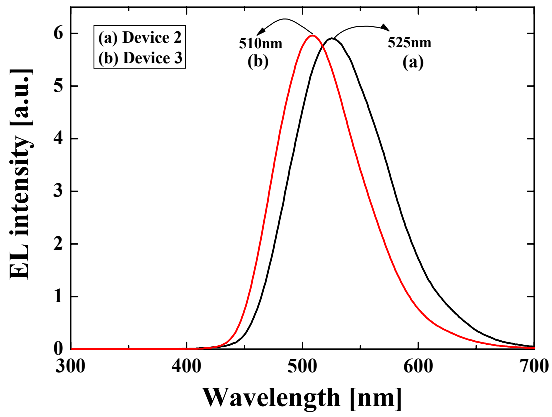
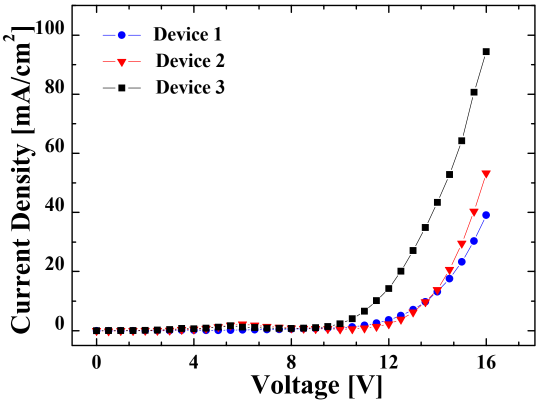
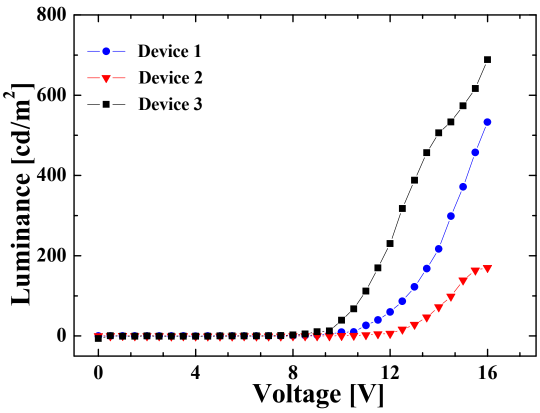


Fig. 4. EL spectrum of the devices 2, 3



(a)



(b)

Fig. 3 (a) Current density-voltage
(b) luminance-voltage characteristics of the devices

Fig. 3. shows the current density-voltage and luminance-voltage characteristics of the devices. Fig. 4. shows EL spectrum. The luminance of device 3 was higher than the others at 16V. In case of device 2 and device 3, the EL spectrum were 510nm and 525nm, respectively. In case of device 3, the increase of luminance implied to balance electron and hole injection because of recombination within emitting layer. The approach discussed here is to efficiently carrier recombination and exciton confinement with OLED by use of electron transporting layer.

4. Conclusions

We synthesized $Zn(PQ)_2$ as the new material. In this study, we used $Zn(PQ)_2$ as hole blocking layer and electron transporting layer. We confirmed electrical and optical properties dependent on each processing condition by fabricating OLED. In device 2, we found very poor performance of $Zn(PQ)_2$ as a hole blocking layer because $Zn(PQ)_2$ used as hole blocking layer was emitting and the device 3, found very performance of $Zn(PQ)_2$ as a electron transprting layer. Therefore, our results suggested that, $Zn(PQ)_2$ has showed better performance as a electron transporting layer than a hole blocking layer.

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