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Study on characteristics of electroluminescence based on Zn complexes

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1. Introduction

Organic metal complexes have recently attracted much attention because of their potential applications in Organic light emitting diodes (OLEDs) [1-6]. 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 kwon example and it has been used as a green emitter or an electron transport material in OLEDs [7]. Recently, Sheng-Gui Liu [8] reported that 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. In this study, we characterized the optical properties of $Zn(HPB)_2$, Zn(phen)q and Zn(HPB)q. We investigate the characterization, fabrication and performance of OLEDs based on new obtained materials.

2. Experimentals

In this experiment, the Indium-tin-oxide (ITO) coated glass substrates had a thickness and sheet resistance of 1500Å and 15Ω/□, respectively. The chemical structures of Zn complexes were shown in Fig. 1.

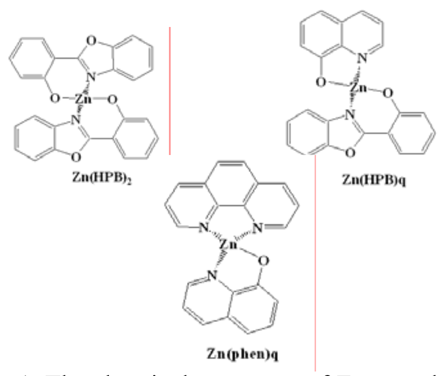

Fig. 1. The chemical structures of Zn complexes.

Redox potentials of the Zn complexes were determined by cyclic voltammetry (CV) using Potentiostat 263A (PerkinElmer, USA). Electrochemical mesurement was performed with 3 electrodes (Ag/Ag^+(0.1M $AgNO_3$) as a reference electrode, Pt wire as a counter electrode and ITO or Al electrode). The constant scan rate was 400mV/sec in 0.1M tetrabutylammoniumperchlorate(Bu_4ClO_4) with acetonitrile [9,10].

Organic EL devices were fabricated using conventional vacuum vapor deposition under a pressure of 2×10^{-6} Torr at room temperature. The device has a double layer structure of ITO / α-NPD (400Å) / Zn complexes (600Å) / Al (1000 Å), in which α-NPD was used as the hole transporting material. The current density-voltage and luminance-voltage characteristics were measured with Flat Panel Display Analysis System (Model 200-AT).

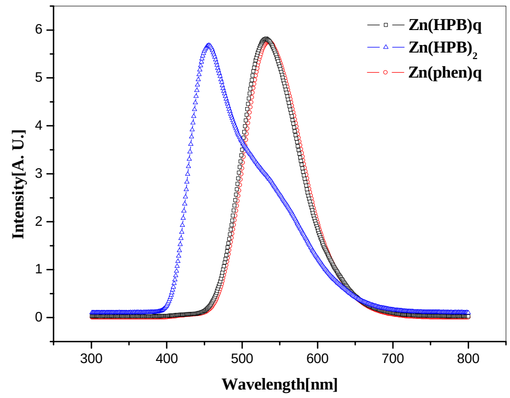

Fig. 2. EL spectra of Zn complexes.

The EL spectra of the devices are shown Fig. 2. The peaks were observed at the wavelength of 455nm, 532nm and 535nm, respectively. $Zn(HPB)_2$ was blue emission and other Zn complexes were observed yellow emission.

The voltammograms measured for Zn complexes. It was found that the films of Zn complexes could be irreversibly oxidized and reduction. The oxidation onset potential and the reduction onset potential of Zn(HPB)q was measured to be +1.72V and –1.32V. Zn(phen)q and $Zn(HPB)_2$ was measured +1.2V, –1.12V and +1.8V, –1.1V, respectively. The electron affinity (EA) of Zn(phen)q, Zn(HPB)q and $Zn(HPB)_2$ are 3.6eV, 3.48eV and 3.0eV, respectively. Also, The ionization potential (IP) of Zn(phen)q, Zn(HPB)q and $Zn(HPB)_2$ are 5.92eV, 6.52eV and 5.9eV, respectively.

Fig. 3 shows the current density-voltage characteristics of the devices used Zn complexes. The current density of device with Zn(phen)q is higher than that of the device with Zn(HPB)q and $Zn(HPB)_2$. It can be seen that EA of Zn(phen)q is lower than that of the Zn(HPB)q and $Zn(HPB)_2$. As EA decreases, the amount of injected carriers increase and the current density of device is increase.

The luminance-voltage characteristics of the device with Zn(phen)q, Zn(HPB)q and $Zn(HPB)_2$ are shown in Fig. 4. It was found that the luminance of the device with Zn(phen)q was higher than that of the devices with Zn(HPB)q and $Zn(HPB)_2$. The Efficiency of the device with Zn(phen)q, Zn(HPB)q and $Zn(HPB)_2$ was 0.7lm/W, 0.25lm/W and 0.1lm/W at the 7V [Fig. 5]. Because of energy barrier lower than other Zn complexes, the device efficiency was increase.

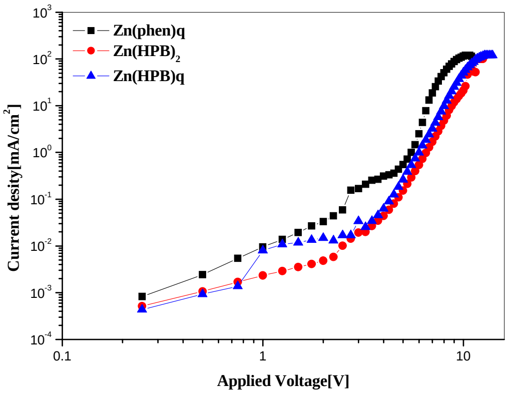

Fig. 3. The characteristics of current density-voltage of devices with Zn complexes as emitting layer.

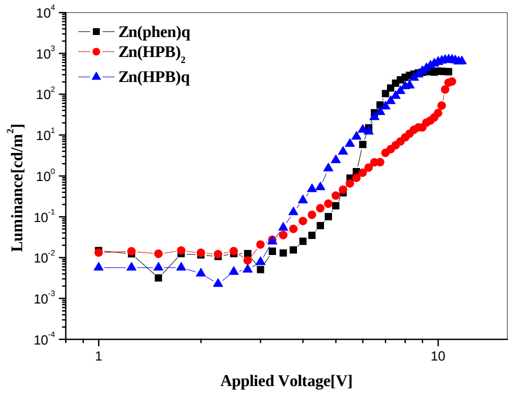

Fig. 4. The characteristics of luminance-voltage of devices with Zn complexes as emitting layer.

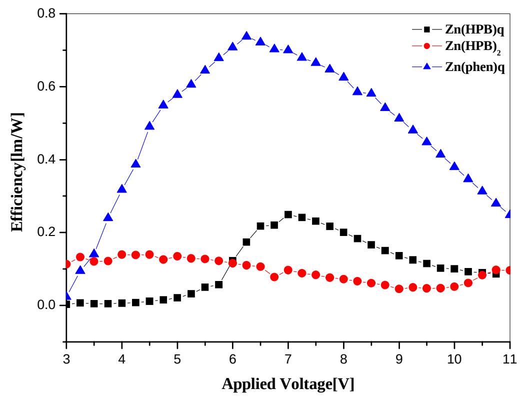

Fig. 5. The characteristics of efficiency-voltage of devices with Zn complexes as emitting layer.

We found that Zn complexes can use hole-blocking materials. Through the CV measurement results, Zn complexes showed possibility as hole blocking material and electron transport material in devices. IP of Zn(phen)q, Zn(HPB)q and $Zn(HPB)_2$ was 5.92eV, 6.52eV and 5.9eV, respectively.

3. Conclusions

We synthesized Zn(phen)q, Zn(HPB)q and $Zn(HPB)_2$, as new electroluminescence materials. We investigated EA and IP of Zn complexes and fabricated device with Zn complexes. Zn complexes such as, Zn(phen)q, Zn(HPB)q and $Zn(HPB)_2$, reported as yellow/blue emission of 535nm, 532nm and 455nm, respectively. It was found that the luminance and efficiency of the device with Zn(phen)q was higher than that of the devices with Zn(HPB)q and $Zn(HPB)_2$. Because EA of Zn(phen)q is lower than that of the Zn(HPB)q and $Zn(HPB)_2$. Also, We found that Zn complexes showed possibility as hole blocking material and electron transport material in devices.

Acknowledgements

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References

[1] C.W. Tang, S.A. Vanslyke, *Appl. Phys. Lett.* 51 (1987) 913.

[2] C.W. Tang, S.A. Vanslyke, C.H. Chen, *J. Appl. Phys.* 65 (1989) 3611.

[3] W. Shirota, Y. Kuwabara, H. India, T. Wakimoto, H. Nakada, Y. Hamadam, T. Sano, M. Fujita, T. Fujii, Y. Nishio, K. Shibata, *Jpn. J. Appl. Phys.* 32 (1993) L514.

[4] V. Bulovic, G. Gu, P.E. Burrows, S.R. Forrest, *Nature* 380 (1996) 29.

[5] C. Adachi, S. Tokito, T. Tsutsui, S. Saito, *Jpn. J. Appl. Phys.* 27 (1988) L713.

[6] Jung Eun Lee, Gyu Chul Choi, Byung O. Rim, Sung min Kim, No Gil Park, Yun Koung Ha, Young Sik Kim, *Materials Science and Engineering C*, 24 (2004) 269-273..

[7] H. Schmidbaur, J. Lettenbaur, D. L. Wilkinson, G. Muller, O. Z. Kumberger, *Naturforscher*, 46 (1991) 901.

[8] Sheng-Gui Liu, Jing-Lin Zuo, Yue Wang, Yi-Zhi Li, Xiao-Zeng You, *Journal of Physics and Chemistry of Solids*, 66 (2005) 735-740.

[9] Jin Young Ock, Hoon Kyu Shin, Dong Jin Qian. Jun Miyake, Young Soo Kwon, *Jpn. J. Appl. Phys.,* 43 4B (2004) 2376-2380.

[10] Jee-Young Park, Oh-Kwan Kwon, Don-Soo Choi, Young-Kwan Kim, Byoung-Chung Sohn, Yun-Kyoung Ha. *J. of Korea Oil Chemists Soc.,* 17 1 (2000) 63-66.