Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Characteristics of Organic Electroluminescent Devices using Alq_3 and TPD Materials with Buffer Layers

Ho-Sik Lee [a], Sam-Ill Kho [b], Taek-Gyun Chung [b], Tae Wan Kim [b], Won-Jae Lee [c] & Dou-Yol Kang [a]

[a] Dept. of Control and Electrical Engineering, Hongik University, 121-791, Sangsudong, Mapoku, Seoul, Korea

[b] Dept. of Physics, Hongik University, 121-791, Sangsudong Mapoku, Seoul, Korea

[c] Dept. of Electronics, Kyungwon University, 461-702, San 65, Bokjug-dong, Soojong-gu, Songnam-shi, Kyonggi-do, Korea

Version of record first published: 24 Sep 2006

Mol. Cryst. Liq. Cryst., 1999, Vol. 327, pp. 189-192
Reprints available directly from the publisher
Photocopying permitted by license only

Characteristics of Organic Electroluminescent Devices using Alq_3 and TPD Materials with Buffer Layers

HO-SIK LEE[a], SAM-ILL KHO[b], TAEK-GYUN CHUNG[b], TAE WAN KIM[b], WON-JAE LEE[c] and DOU-YOL KANG[a]

[a]*Dept. of Control and Electrical Engineering, Hongik University, 121–791, Sangsudong, Mapoku, Seoul, Korea,* [b]*Dept. of Physics, Hongik University, 121–791, Sangsudong Mapoku, Seoul, Korea and* [c]*Dept. of Electronics, Kyungwon University, 461–702, San 65, Bokjug-dong, Soojong-gu, Songnam-shi, Kyonggi-do, Korea*

(Received June 30, 1998; In final form July 30, 1998)

Organic electroluminescent devices were fabricated using Alq_3(8-hydroxyquinolinate aluminum) and TPD(N,N′-diphenyl-N,N′-bis(3-methylphenyl)-[1-1′-biphenyl]-4,4′-diamine). We investigated current-voltage characteristics of the EL devices having buffer layer of PEI (Poly ether imide) blended with TPD, and conducting polymer PEDT(3,4-pyrazino-3′,4′-ethylenedithio-2,2′,5,5′-tetrathiafulvalenium). We measured UV/visible absorption spectrum, and PL(Photoluminescence) spectrum.

Keywords: organic electroluminescent devices; current-voltage characteristics

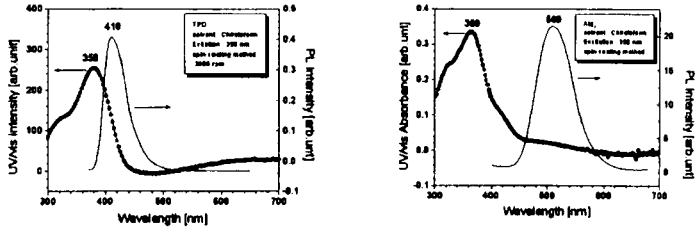
INTRODUCTION

Electroluminescent(EL) devices based on organic thin films have attracted lots of interests in large-area light-emitting display. One of the problems of such device is a lifetime, where a degradation of the cell is possibly due to an organic layer's thickness, morphology and interface with electrode. Light emission is arising from the singlet polraronic exciton resulting from the recombination of negative polaron (p^-) and positive polaron (p^+), generated from electron and hole injected within emissive layer[1],[2]. In organic thin film EL device, emission occurs by way of the following processes; (a)

double charge carrier injection from anode and cathodes into organic layers, (b) charge carrier transport crossing organic layers, (c) recombination of transported charge carriers and creation of singlet polaronic exciton, (d) migration of singlet polaronic excitons and (e) radiative decay of polaronic excitons. Process (a), (b), (c) and (d) involve the efficiency of production of singlet polaronic excitons, which is the one of the major factors that control total quantum efficiency of EL. Recently, organic blends dispersed polymer matrix have acted to focus attention on the color tuning and improvement of efficiency by selecting the component organic dyes in blends[3],[4]. In this study, we observed electrical properties of the EL devices by measuring the current-voltage characteristics, luminescence-voltage characteristics, and optical properties such as a UV/visible absorption, PL spectrum and EL spectrum.

EXPERIMENTS

Where $Alq_3(C_{22}H_{18}AlN_3O_3$, 459.44) is an electron-transport and emissive material, TPD($C_{38}H_{32}N_2$, 516.69) is a hole transport material. We used ITO-glass(Samsung Corning) as a bottom electrode and Al as a top electrode made by vacuum evaporation at 10^{-5} torr. ITO-glass was cleaned using two steps. The first step was boiling the ITO-glass in H_2O_2 solution of ammonia and distilled water at 100℃ with 1 hour. The second step is ultrasonic cleaning with distilled water at 1hour. Buffer layer with blend of PEI(Poly ether imide) and TPD was used by varying mol ratios between ITO and Alq_3. The Alq_3 was deposited by vacuum evaporation at 10^{-5} torr. Cell structures are ITO/TPD/Alq_3/Al and ITO/(TPD+PEI)/Alq_3/Al..



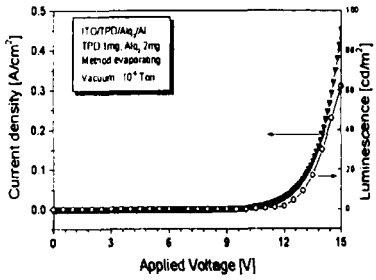
(a) TPD (b) Alq_3

FIGURE 1 UV/visible absorption and PL spectrum of (a) TPD film and (b) Alq_3 film.

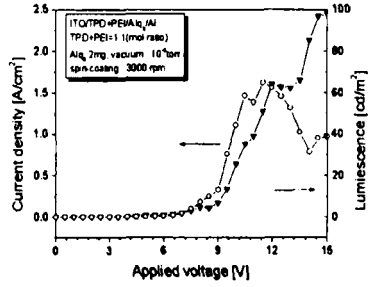
Other cell structure is ITO/PEDT/TPD/Alq_3/Al where PEDT(polyethlyene dioxyphenlene) is a conducting polymer, and deposited it by spin-coating method. UV/visible absorption spectra was measured using HP8452A spectrophotometer and PL spectrum using Perkin Elmer Limited LS50B.

RESULTS AND DISCUSSION

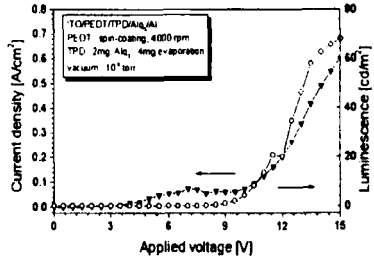
Figure 1 shows UV/visible absorption and PL spectrum of TPD film and Alq_3 film. In figure 1, there is an absorption peak at 358nm and PL peak at 410nm in TPD film. And there is an absorption peak at 359nm and PL peak at 509nm in Alq_3 film.



(a) ITO/TPD/Alq_3/Al



(b) ITO/(PEI+TPD)/Alq_3/Al



(c) ITO/PEDT/TPD/Alq_3/Al

FIGURE 2 Current-voltage characteristics and brightness of the EL device.

We observed the EL spectrum at about 510nm. From the above result, our cell emits a green color. Current-voltage (*I-V*) and luminescence-voltage characteristics were measured in each cell structure, as shown in Fig. 2.
In figure 2(a), we observed a turn-on voltage at 9V and the brightness was 62cd/m^2 at 15V. In figure 2(b) turn-on was at 6V and the brightness was 85cd/m^2 at 12V. In figure 2(c), we observed a turn-on voltage at 4.5V and the brightness was 65cd/m^2 at 15V. From the current-voltage measurements we confirmed that the turn-on voltage was decreased after using buffer layer at the same thickness of the Alq_3. When we plotted log(current density) vs. log(luminescence), it shows a linear relation between current density and luminescence.

CONCLUSIONS

From the above study we conclude the followings. Using the buffer layer of PEI with blending TPD, the turn-on voltage was decreased from 9V to 6V. And using buffer layer of PEDT between ITO and TPD, the turn-on voltage was also decreased from 9V to 4.5V. Further study of interface between organic and metal are needed to improve. We confirmed that we need further study in the stability and the efficiency of the EL cell.

Acknowledgments
The present studies were supported by the Basic Science Research Institute Program, Ministry of Education, 1998, Project No. BSRI-98-2428.

References

[1] Hamaguchi, M. and Yoshino, K., *Jpn. J. Appl. Phys.*, **36,** L712 (1995).
[2] Y. Yang, Q. Pei and A. J. Heeger, *Synth.. Met.*, **78,** 363 (1996).
[3] C. Adachi, T. Tsutsui, and S. Saito, *Appl. Phys. Lett.*, **56,** 799 (1989).
[4] C. W. Tang, and S. A. VanSlyke, *Appl. Phys. Lett.* **51,** 913 (1989).