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

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Version of record first published: 24 Sep 2006

To cite this article: Ho Chul Lee, Kwan Sik Jang, Jong Ju Park, Eung Ju Oh & Moo Whan Shin (1999): Processing Effects of the Polyvinyl-Butyrol-Based Binder on the Performance of Electroluminescent Diodes, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 337:1, 493-496

To link to this article: http://dx.doi.org/10.1080/10587259908023485

Mol. Cryst. and Liq. Cryst., 1999, Vol. 337, pp. 493-496
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Processing Effects of the Polyvinyl-Butyrol-Based Binder on the Performance of Electroluminescent Diodes

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The processing effects of polyvinyl-butyrol (PVB)-based binding organics (PBBO) on the characteristics of the ZnS:Cu electroluminescent (EL) devices are discussed. The characteristics of the EL devices fabricated using the PBBO are compared with those of devices fabricated using a membrane switch composition (MSC). It is demonstrated that the performance of the PBBO be comparable with the MSC. The brightness and the output current of devices using PBBO at 100 V and 400 Hz are 55 cd/m^2 and 2.2 mA, respectively. The reliability test performed under the harsh environment (333 K and 90 % RH) exhibits the life time (time at the half of the original brightness) of device longer than 140 hr.

Keywords: electroluminescent devices; binder; current-voltage characteristics; reliability; brightness; printing process

INTRODUCTION

Electroluminescent devices(ELDs) have great potential for the next generation flat panel display due to the low power consumption, high resolution and faster response time, wide viewing angle, and availability in a compact device structures[1-3]. The ELD generally consists of light emitting layer, dielectric layer, and electrode layers with the outmost coating layers. In the processing of device fabrication, binders are utilized for solid and

endurable formation of the light emitting layer and dielectric layer. It is well known that the characteristics of the organic binders directly affect the performance of ELDs[4-5]. Employing of proper binders is very important for the reduction of cost for the final product. The most common organic binder utilized in the fabrication of ELDs is the membrane switch composition (MSC). In this paper, the processing effects of a new organic binders on the electrical and optical characteristics of ELDs are discussed.

EXPERIMENTS

The organic binder employed for this experiments was synthesized by ourselves using the PVB-based organic (PPBO) materials. The fabricated EL device consists of light-emitting layer, dielectric layer, and two metal electrodes. The fabrication process is a typically used route and is described elsewhere in detail[1]. The light-emitting layer is a mixture of micro-encapsulated ZnS:Cu phosphors and binder resins. Each layer of device is obtained by employing the screen printing technique followed by appropriate annealing procedures. The number of screening printing process for the light emitting layer and the dielectric layer was taken as one of the processing parameters.

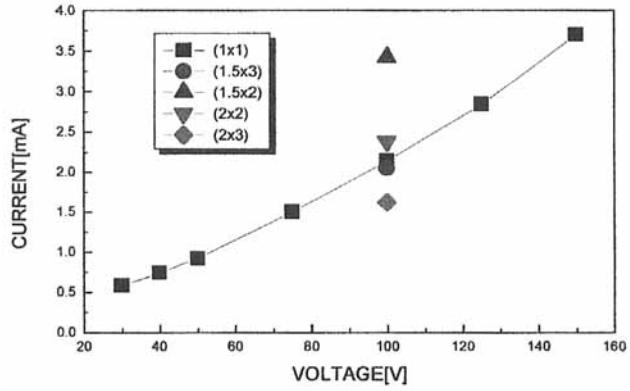

FIGURE 1 I-V characteristics of the fabricated ELDs with single printing process for both light emitting layer and dielectric layer(1 x 1 process). Data points at 100 V for devices with various processing are also included for 1.5 x 3 process(●), 1.5 x 2 process(▲), 2 x 2 process(▼), and 2 x 3 process(◆)

RESULTS AND DISCUSSION

The current-voltage characteristics of the devices which utilize the binder PPBO is shown in Fig. 1. The current-voltage characteristics of the devices show a typical trend of the semiconductor p-n diodes. It shows that the performance of the devices strongly depends on the processing parameters. The current levels at 100 V are shown for various devices fabricated by different processing routes described in the figure caption. The devices fabricated using the binder MSC exhibit the average brightness of 65 cd/m^2 at the applied voltage of 100 V at 400 Hz. The power consumption from the operation was ranged from 0.06 to 0.062 W and the output current under the conditions was about 2.30 mA. Fig. 2 shows the brightness of devices as functions of the applied voltage and the processing routes. Comparing with

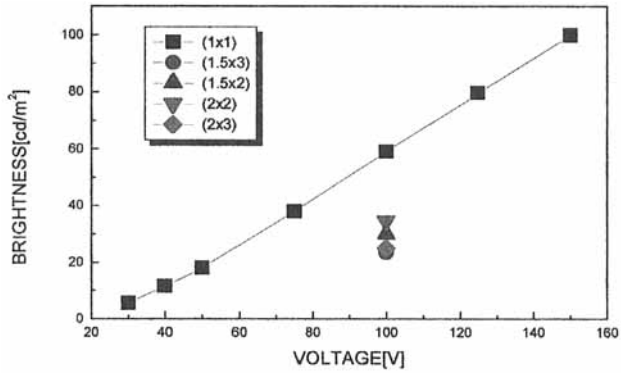

FIGURE 2 Brightness vs. applied voltage plot for devices fabricated using different processing routs as described in FIGURE 1.

the results of Fig. 2, it is concluded that the performance of devices is controlled by several physical parameters such as contact resistance or interface characteristics between each layers, otherwise, the brightness would increase with the current. When the mixture ratio between the binder and the phosphors was increased from 0.6 to 1.2, the brightness was shown to increase from about 30 to 58 cd/m^2. The brightness was shown to increase with the applied voltage as expected; 10 cd/m^2 at 40 V and as high as 100 cd /m^2 at 150 V for the 1 x 1 sample. The power consumption of the device at 150 V was about 0.25 W. The power consumption was significantly higher for the device with higher binder/phosphor ratio due to the higher resistivity of the binder than that of the phosphor . Fig. 3 compares the results of a

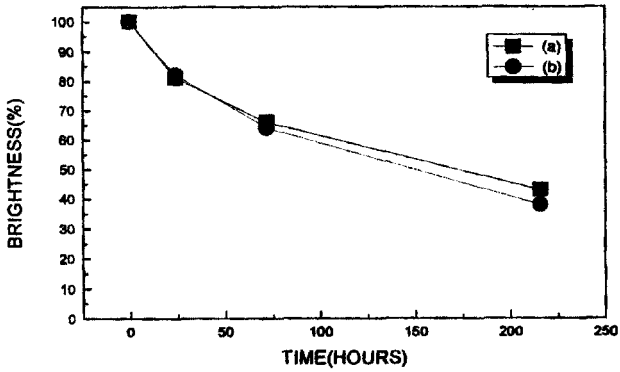

FIGURE 3 Results of reliability test performed at 60 ℃ with 90 % RH for samples using (a) binder with membrane switch composition and (b) PVB-based binder.

reliability test between the samples fabricated by the binder PPBO and the samples fabricated by the binder MSC. The reliability test was performed at 333 K under 90 % of RH. It is demonstrated that the performance of the binder PPBO be comparable with the binder MSC.

SUMMARY

The potential of polyvinyl-based binding organics(PBBO) was evaluated for the fabrication of the ZnS:Cu electroluminescent devices. It was shown that the performance of the devices using the PBBO could be comparable with that of the devices fabricated using the membrane switch composition(MSC).

Acknowledgments
The authors wish to acknowledge the financial support of the Korean Research Foundation made in the program year of 1998. Experimental process was partially assisted by the Shin Pyung Co.

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