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

Mol. Cryst. and Liq. Cryst., 2000, Vol. 349, pp. 471-474
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The optical properties of electroluminescent device (EL) fabricated using Alq_3, (8-hydroxyquinoline)aluminum) and TPD (N, N′-bis (-3-methylphenyl)-(1,1′-biphenyl)-4,4′-diamine) with CuPc (copper phthalocyanine) buffer layer were investigated. The triple-layered EL device consists of five layers, ITO/CuPc/TPD/Alq_3/Al and the cell was fabricated by the vacuum evaporation method. We obtained a turn-on voltage at 5 V and the maximum emission peak at 525 nm from the measurement of EL spectrum, and EL intensities tend to increase with increasing applied voltage.

Keywords: organic photoconductor; copper phthalocyanine; Alq_3; emission spectrum

INTRODUCTION

It has been aroused an interest in CuPc, the one of useful derivatives which have the greatest commercial importance in the field of organic photoconductor. The thin films were prepared by vacuum evaporation technique. Molecular orientations are varied depending on the substrate and deposition conditions, particularly in the case of CuPc [1]. Tang et al. derived the improvement of stability by optimizing the thickness of the multilayer thin film with a CuPc stabilized hole-injection contact [2].

We have already investigated the formation mechanism of thin films

from the thermodynamic point of view for several organic materials such as organic dye [Alq_3, and TPD] [3,4], fullerene (C_{60}) [5 ~ 7] and CuPc [1]. It has been expected that phthalocyanine as a planar molecular is affected in the molecular orientation by the surface temperature [1]. In this paper, we investigated the I-V characteristic of the EL intensity depending on the substrate temperature (Ts) during Cu-Pc deposition.

EXPERIMENTAL

The organic EL device structure used in this work is shown in Figure 1. CuPc, Alq_3 and TPD were purchased from Aldrich Fine Chemicals, America and employed without any further purification.

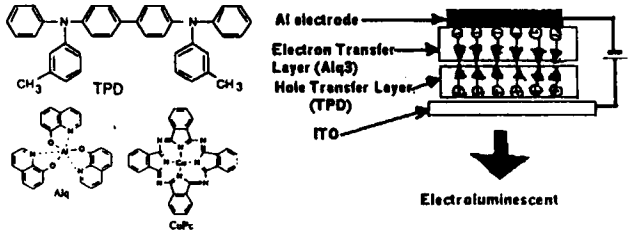
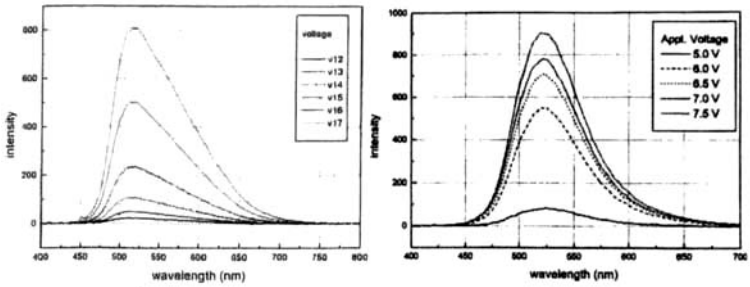


FIGURE 1. EL device configuration and molecular structures.

The emitting layer was Alq_3 and TPD was used for the hole transport layer. An additional layer, CuPc, was inserted between TPD and the indium-tin-oxide (ITO) electrode having a sheet resistance of ca. 10 ~ 20 Ω /cm^2. All organic layers were deposited on the ITO coated glass by vacuum vapor deposition (~10^{-6} Torr). The adhesive tape purchased from 3M company was put on the ITO coated glass with double layers. It was then cut in the shape of stripe having 2mm width. Then every other piece of tape was removed. The ITO-coated glass prepared as above was immersed into an aqua regia for 10 minutes to etch the place of the removed tape. After finishing etching, it was washed out by immersing the ITO coated glass into tap water and deionized water. The remaining adhesive tape was then removed very carefullly. The ITO coated glass was cleaned by sonification with detergent/de-ionized (DI) water for 1 hour, acetone for 30 minutes, ethanol for 1 hour and dried in vacuum at 90 °C for 15 hours and finally treated in a u.v.-ozone chamber. The u.v.-ozone treatment was carried out in an u.v.-ozone cleaning system with u.v. emission from a Xe ARC lamp whose intensity was 300 w/cm^2 at one inch from the lamp. After the deposition of the organic layers, the Al electrode was deposited on the top of the organic layers by employing

tungsten filament and aluminum-rod purchased from Sigma-Aldrich. The active area of the EL device used in this experiment was 0.1 cm^2. The EL luminescent intensity and spectrum were measured using an Ocean Optics S2000 Fibre Optic Spectrometer with a CCD-array detector. The dc voltage and current source were used to trace current-voltage characteristics.

RESULTS AND DISCUSSION



(a) (b)

FIGURE 2. EL spectra of (a) the double-layered EL structure ITO /TPD/ Alq_3/ Al and (b) the triple-layered EL structure ITO / CuPc / TPD/ Alq_3 / Al.

EL spectra at various applied voltages and intensity-voltage properties of the double-layered EL structure ITO/TPD/Alq_3/Al are illustrated in Figure 2(a). Through the measurement of the EL spectrum, we obtained a turn-on voltage of 12 V and maximum emission peak at 525 nm. The EL intensities tend to increase with increasing applied voltage. In order to clarify the role of the buffer layer, CuPc, we measured luminescence intensity for the triple layered EL structure ITO/CuPc/TPD/Alq_3/Al and their results are shown in Figure 2(b).

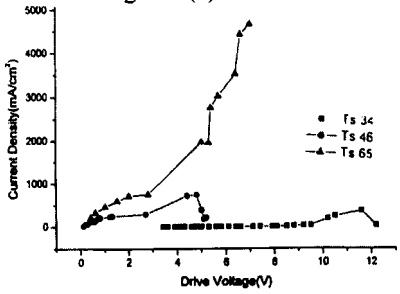


FIGURE 3. Current-voltage characteristics of and ITO/CuPc(15 nm)/TPD(61 nm)/Alq_3(61 nm)/Al(150 nm) cell at Ts 34, 46, 65 °C.

In this case, the turn on voltage was 5 V, which is much lower than that of the double layered structure. The luminescent intensity of the EL cell with buffer layer is stronger than that of the EL cell without a buffer layer [7]. These results might be due to the low barrier of ITO/CuPc, originating from the lower ionization potential of CuPc (4.7 eV) relative to TPD and are consistent with Tang's result [2]. Figure 3 shows the I-V characteristic of the device depending on the substrate temperature during Cu-Pc deposition. The Cu-Pc films consisted of granular islands form. It was observed that the EL intensity of the device due to the substrate temperature was enhanced by increasing the granularity of Cu-Pc which can be controlled.

In conclusion, we have demonstrated that the luminescent intensity of the organic EL device based on thin film Alq_3. It was increased by inserting the CuPc buffer layer. The lower turn-on voltage of 5 V is achieved by using the multilayer device structure in this work.

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[7] By raising the CuPc surface temperature higher than room temperature, we observed that turn-on voltage was decreased and that luminescence intensity increased.