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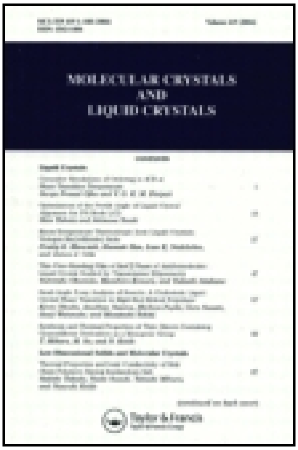

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PTCDA/PPET Heterostructure Light Emitting Diode

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PTCDA/PPET Heterostructure Light Emitting Diode

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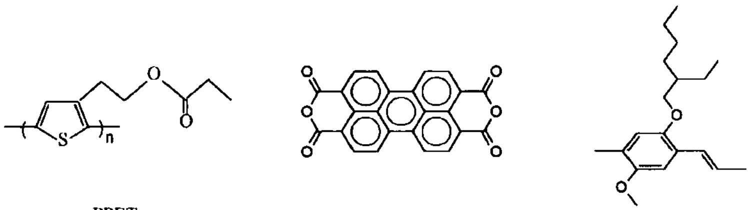
Multilayered EL devices were fabricated using PPET as the emitting layer and PTCDA as a hole transporting layer. A light emitting diode with PTCDA/PPET showed light emission from PPET layer and PTCDA only acted as a hole transporting layer. PTCDA/PPET EL device showed enhanced luminance efficiency than PPET EL device.

Keywords: multilayer EL device; PPET; PTCDA hole transporting layer

INTRODUCTION

Electroluminescence (EL) devices using organic materials have been attracted substantial interest for large-area display devices and other applications. Recently, high luminance and high efficiency have been realized in organic thin film EL devices with multilayer structures, which included an emitting layer, a hole transporting layer and electron transporting layer.[1-2] In the multilayered EL device, the confinement of charge carriers in emitting layer can be accomplished using the carrier transporting materials with higher excitation energy than that of emitting material. As a result of these confinement effects, highly efficient EL can be attained.[3-4] Therefore study of different combination of hole transporting and electron transporting materials would help to guide the selection of appropriate materials for each layer.

In this study, we fabricated a double layer structure EL device using 3,4,9,10-perylenetetracarboxylic anhydride (PTCDA) as a hole transporting layer and poly(3-propanoyloxy-2-ethylthiophene) (PPET) as the emitting layer. The effects of PTCDA layer on the operational characteristics of the emitting devices were examined.



PPET PTCDA MEH-PPV

FIGURE 1 Molecular structures of poly(3-propanoyloxy-2-ethylthiophene) (PPET), 3,4,9,10-perylenetetracarboxylic anhydride (PTCDA) and poly(2-methoxy, 5-(2'-ethylhexoxy)-1,4-phenylenevinylene) (MEH-PPV)

EXPERIMENTAL

Figure 1 shows the structures of materials used in this study. PPET was prepared according to the reported method.[6] Electronic absorption spectrum was measured with Shimadzu 160A UV/Vis spectrophotometer and fluorescence and EL spectra were recorded using a SPEX Fluoromax.

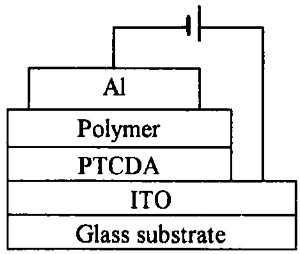


FIGURE 2 Schematic diagram of the electroluminescent device

In figure 2, a schematic diagram of light-emitting diode fabricated in this experiment was illustrated. The ITO electrode was cleaned by successive ultrasonic treatment in acetone and isopropyl alcohol and PTCDA layer was deposited on the ITO glass at deposition rate of 0.1Å/s. And then a solution of polymer in chloroform was spin coated on the ITO substrate at a rate of 2000rpm for 20sec. Aluminum cathode was deposited on the polymer film at pressure below 2×10^{-5} torr. All the measurements mentioned above were performed at room temperature in air DC bias conditions.

RESULTS AND DISCUSSION

Figure 3 shows absorption and photoluminescence spectra of PTCDA, MEH-PPV, POT and PPET. From absorption edges of each material, the band gaps of PTCDA, MEH-PPV and PPET have been estimated to be 2.07, 2.14, and 2.25. And photoluminescence maxima of MEH-PPV and PPET are shown at 580nm and 595nm and that of PTCDA is shown at 710nm. Figure 4 shows current-voltage (I-V) characteristics of four devices. The I-V curves show typical diode characteristics.

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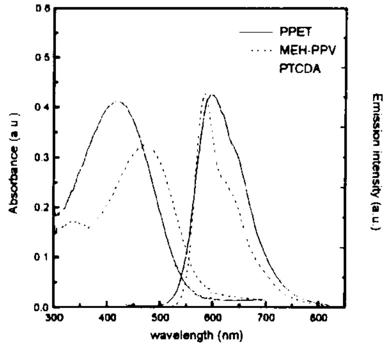


FIGURE 3 Absorption and PL spectra of PPET, MEH-PPV and PTCDA

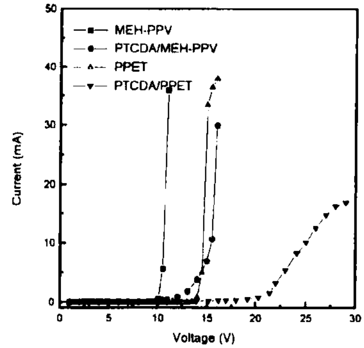
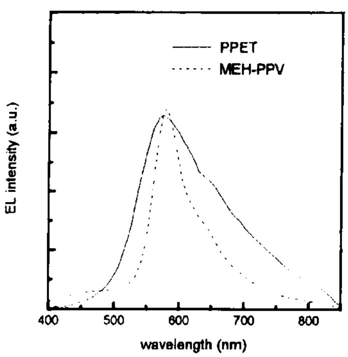


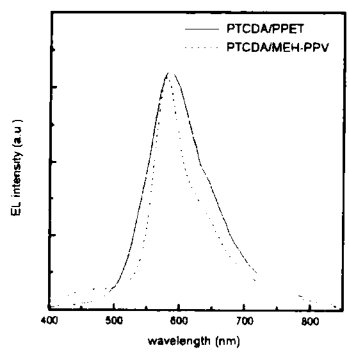
FIGURE 4 Current-voltage characteristics of four different devices

The threshold voltage of MEH-PPV and PPET are 10V and 14V and those of PTCDA/MEH-PPV and PTCDA/PPET are 12V and 20V, respectively. Insertion of PTCDA layer as the hole transport layer results in increase of threshold voltage but does not effect on the current.

Figure 5 shows electroluminescence spectra of single layer and double layer devices. Orange emission was observed for all of EL devices when a dc voltage was applied to the ITO electrode. In figure 5, electroluminescence spectra of double layer devices show emission peak at 580nm, which correspond to the emission from the single layer devices. This indicates that light is emitted from conjugated polymer layer and PTCDA layer acts as the hole transporting layer. Also, peak width narrowing was



a)



b)

FIGURE 5 Electroluminescence spectra of a) single layer devices b) double layer devices

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observed for PTCDA/PPET double layer device.

The efficiency of EL devices was measured under applied DV voltage from 8V to 20V. The relative efficiency was defined as the emission intensity divided by the current density. The PTCDA/PPET double layer device showed about 8 times higher relative efficiency than that of PPET single layer device whereas PTCDA/MEH-PPV double layer device has similar efficiency to that of MEH-PPV single layer device. It can be assumed that PTCDA in PTCDA/PPET device is blocking electrons, thus preventing electron from moving into ITO electrode without recombining with holes but PTCDA in PTCDA/MEH-PPV device does not block electrons.

The double layer devices also showed the enhancement of stability due to decrease of leak current during operation. The insolubility of PCTDA in common organic solvent is essential for the use of PTCDA as the underlying layer.

CONCLUSION

Multilayer EL devices are fabricated using conjugated polymer as the emitting layer on the top of PTCDA.. PTCDA/PPET double layer device showed higher efficiency than PPET single layer device but no such effect was observed for MEH-PPV device.

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