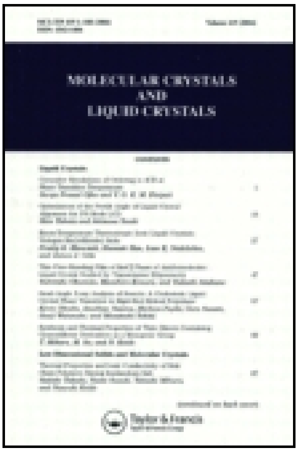

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Electroluminescence Characteristics of Polymer Blend PBET and MEH-PPV

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Poly[3-(2-benzotriazoloethyl)thiophene] (PBET) containing an electron transporting moiety was blended with poly[2-methoxy-5-(2'-ethylhexyloxy)-1,4-phenylene vinylene] (MEH-PPV) by changing their composition ratio. The MEH-PPV was used as a hole transporting material. The blends were characterized by UV-vis, photoluminescence (PL), and electroluminescence (EL) studies. The external EL quantum efficiency was enhanced by blending; i.e. greater than in pure PBET by a factor of two in the blend film with weight ratio (PBET : MEH-PPV = 5 : 1).

Keywords: polythiophene; polyphenylene vinylene; LEDs.

INTRODUCTION

Since the fabrication of polymer light-emitting diodes (PLEDs) was reported in 1990[1], the PLEDs have been the subject of intense research interests recently due to its optical and electronic properties of semiconductors with the processing advantage and mechanical properties of polymer[2].

In our early study, poly(3-(2-benzotriazolo)ethylthiophene) (PBET) was synthesized to increase a quantum efficiency by introducing benzotriazole, an electron with drawing moiety, to the thiophene[3]. Even though the quantum efficiency was increased, the enhancement was not significant. So poly(2-methoxy-5-(2'-ethyl-hexyloxy)-1,4-phenylene vinylene) (MEH-PPV) was inserted between PBET emitting layer and ITO substrate to enhance the efficiency and to lower a turn-on voltage. The MEH-PPV was selected as a hole-transporting material based on the consideration of its electronic structure. Using this dual-layer structure, the efficiency and a turn-on voltage were improved clearly[4]. The structures of the polymers are shown in Figure 1. In this work, electroluminescence (EL) and photoluminescence (PL) from blend films made of PBET and MEH-PPV were measured. The light-voltage-luminance (I-V-L) characteristics by blend ratio were also investigated.

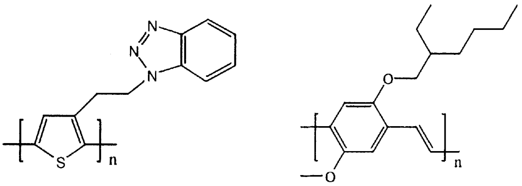

FIGURE 1. Chemical structures of PBET and MEH-PPV.

EXPERIMENTAL

Polymers, MEH-PPV and PBET, were solved in 1, 1, 2, 2-tetrachloroethane (TCE). Solutions of polymer blends, with MEH-PPV/PBET ratio varying from 1/5 (20 wt.%) to 1/20 (5 wt.%), were prepared in TCE. Polymer films were spin-coated onto glass at 3000 rpm for 30 sec from the TCE solution (0.04 g/mL) yielding a film with thickness of 100-120 nm. To investigate EL characteristics, polymer films were spin-coated onto indium-tin oxide (ITO) glass in the same manner. On the top of these films, a 120 nm thick Al layer was evaporated at pressure below 10^{-6} torr. All processing steps for EL characteristic measurements were carried out in air and at room temperature.

RESULTS AND DISCUSSION

The UV-vis absorption spectra of the PBET, MEH-PPV, and polymer blend films are shown in Fig. 2 (a). The absorption peak of PBET is appeared at 440 nm. Maximum absorption peak at 510 nm originates from MEH-PPV. Absorption peaks of the polymer blends are shown from 440 to 453 nm, corresponding to the blend ratio. In PL emission spectra as shown in Figure 2 (b), the emission peak of the PBET occurs at around 584 nm, and those of the polymer blends range from 586 to 588 nm as the blend ratios change. The highest PL intensity is obtained for the polymer blend film of PBET with 10 wt.% MEH-PPV.

Figure 3 shows the original and normalized EL emission spectra of Al/PBET/ITO and Al/polymer blend/ITO devices. From the normalized spectra, the emission peak of PBET is observed at 594 nm. The emission

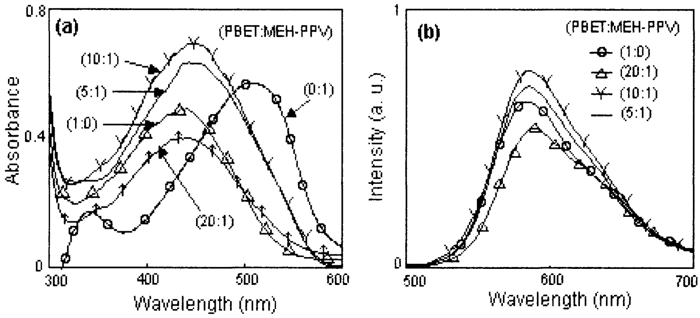

FIGURE 2. (a) UV-vis absorption spectra of the PBET, MEH-PPV, and polymer blend films. (b) PL emission spectra of PBET and the polymer blends.

peaks of the polymer blends are red-shifted from 594 to 604 nm with increasing blend ratio of MEH-PPV, and intensities of the shoulder peaks at 636 nm increase. The light intensities of the polymer blends are stronger than that of PBET as shown in Figure 3 (b). The EL intensity is enhanced by blending. The EL spectrum from an Al/polymer blend/ITO device (20 wt.% MEH-PPV in PBET) shows the highest EL intensity compared with the corresponding spectra from devices made with pure PBET and other polymer blends.

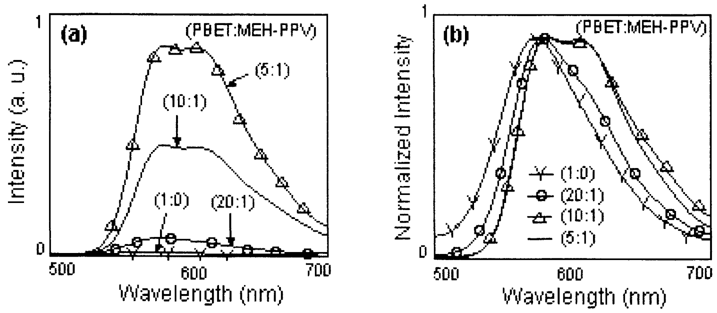

FIGURE 3. (a) Original and (b) normalized EL spectra of Al/PBET/ITO and Al/polymer blend/ITO devices, for several blend ratios.

The current-voltage (I-V) and voltage-luminance (V-L) characteristics of the Al/PBET/ITO and Al/polymer blend/ITO devices are illustrated in Figure 4, for several blend ratios. The turn-on voltage and external quantum efficiency of the devices are summarized in Table 1. The external EL quantum efficiency is improved by blending; i.e. greater than in pure PBET by a factor of two in the blend film with weight ratio (PBET : MEH-PPV = 5 : 1).

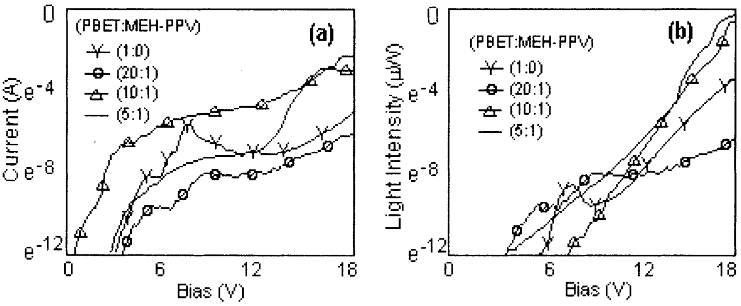

FIGURE 4. (a) I-V and (b) V-L characteristics of Al/PBET/ITO and Al/polymer blend/ITO devices.

TABLE 1. Turn-on voltage and external quantum efficiency of Al/PBET/ITO and Al/polymer blend/ITO devices

Blend ratio (PBET : MEH-PPV)	1 : 0	20 : 1	10 : 1	5 : 1
Turn-on voltage	5.8 V	5 V	7 V	2.8 V
Q. E. ($\times 10^{-4}$ %)	5.1	6	6	11

CONCLUSIONS

The PBET was blended with MEH-PPV as a hole transporting material. The EL characteristics of the devices based on PBET are improved by blending with MEH-PPV.

Acknowledgment

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