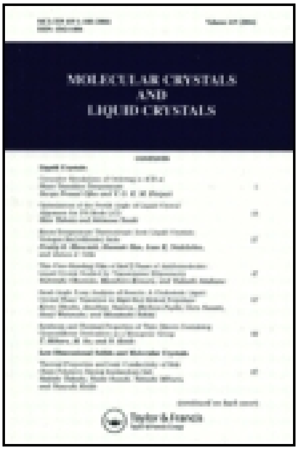

Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

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

Color Tunable Electroluminescence From Polymer Blends Containing Carbazole Unit

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To cite this article: Seok-Hee Lee, Sung-Ho Jin, Seong-Bae Moon, In-Sung Song, Woo-Hong Kim, Sun-Ki Kwon, Nam-Kook Park & Eun-Mi Han (2000): Color Tunable Electroluminescence From Polymer Blends Containing Carbazole Unit, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 349:1, 507-510

To link to this article: http://dx.doi.org/10.1080/10587250008024973

Mol. Cryst. and Liq. Cryst., 2000, Vol. 349, pp. 507-510
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Color Tunable Electroluminescence From Polymer Blends Containing Carbazole Unit

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The electro-optical properties of poly(phenylenevinylene-alt-N-hexyl-carbazolevinylene), [Poly(PPV-N-hexylCvz)], poly[1′,4′-phenylene-1″, 4″-(2″-(2⁗-ethylhexyloxy))phenylene-2,5-(1‴,4‴-phenylene)-1,3,4-oxadiazolyl](PPEPPO) and their blends were characterized. The photoluminescence and electroluminescence spectra of the blend films composed of Poly(PPV-N-hexylCvz) and PPEPPO were mainly contributed from the luminance of Poly(PPV-N-hexylCvz) even at low Poly(PPV-N-hexylCvz) ratios. Remarkably enhanced EL efficiency was observed as the ratio of PPEPPO increased. As the ratio of PPEPPO was increased from 50 to 83 %, the EL emission was changed from green to blue color.

Keywords: electroluminescence; energy transfer; polymer blend

INTRODUCTION

Polymer electroluminescence (EL) devices [1] have been widely studied for application in thin film display. The characteristics of the polymer EL devices are determined by the balanced injected charges, which is crucial in achieving high quantum efficiency. The most efficient devices reported are the multi-layered structures which comprises with another charge transporting layers. However, the fabrication of multi-layered devices is tedious and difficult to selection of the appropriate layers to optimize the device performance. To solve this problem, the blend polymers as the emitter sandwiched between two electrodes is also a good way, not only to improve the EL efficiency, but also to change the emission color dependent on blend polymers [2]

In this paper, we report color tunable EL diodes using the blended thin films of poly(phenylenevinylene-alt-N-hexylcarbazolevinylene) [Poly(PPV-N-hexylCvz)] and poly[1,4-phenylene-1',4'-(2'-methoxy-5'-ethylhexyloxy)phenylene-1",4"-phenylene-2,5-oxadiazolyl] (PPEPPO).

EXPERIMENTAL

Molecular structures of the synthesized Poly(PPV-N-hexylCvz)] and PPEPPO are shown in Fig. 1. EL devices consist of a blend polymer film sandwiched between two thin electrodes. The weight ratio of Poly(PPV-N-hexylCvz)/PPEPPO was varied. About 100nm-thick blend film was obtained by spin casting onto an ITO as an anode. An aluminum cathode was evaporated by conventional vacuum deposition at pressures below 4 x 10^{-6} Torr. Photoluminescence (PL) and EL spectra were recorded with an ISS PC Spectrofluorometer. All measurements including the current-voltage-luminance characteristics of the EL devices were performed under N_2 atmosphere.

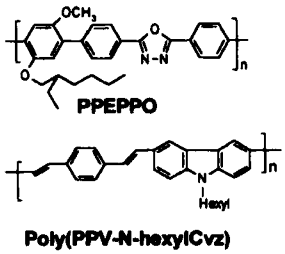

FIGURE 1. Chemical structures of polymers used in this study

RESULTS AND DISCUSSION

UV-visible absorption spectra of Poly(PPV-N-hexylCvz) and PPEPPO were obtained, which had a maximum peak at 382 nm and peaks at 330 and 366 nm, respectively. When the blend ratio of Poly(PPV-N-hexylCvz) and PPEPPO was varied, the strength of each peak of UV-visible absorption spectra was proportioned to the concentration of the

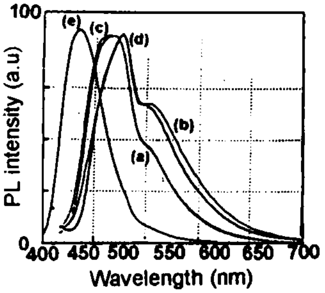

FIGURE 2 Normalized PL spectra of the Poly(PPV-N-hexylCvz), PPEPPO, and their blend films

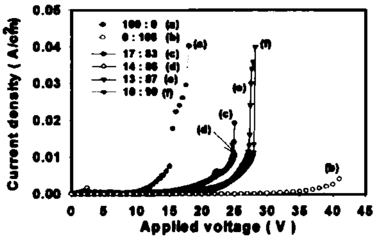

FIGURE 3 Current density-voltage characteristics of ITO / Poly(PPV-N-hexylCvz) / Al (a), ITO / PPEPPO /Al (d), and ITO / blend of Poly(PPV-N-hexylCvz)-PPEPPO / Al devices (b~c)

PPEPPO and the position of the maximum absorption wavelength was not changed, which means that there were no interactions between Poly(PPV-N-hexylCvz) and PPEPPO at the ground state.

Figure 2 shows the normalized PL spectra of the polymer films which were excited at 370 nm. Poly(PPV-N-hexylCvz) (a) and PPEPPO (e) have two maximum peaks at 490 and 520 nm and a peak at 440 nm, respectively. Regardless the content of PPEPPO in the blend films (b~d), strong PL peak was observed from Poly(PPV-N-hexylCvz) though PPEPPO also was photo-exited, which may be due to the efficient energy transfer from photo-exited PPEPPO to Poly(PPV-N-hexylCvz). With increase of PPEPPO content, the maximum PL peak from Poly(PPV-N-hexylCvz) is blue-shifted to about 10 nm, which was caused by the chain conformation effect.

Figure 3 shows the current density-voltage characteristics of ITO /Poly(PPV-N-hexylCvz)/Al (a), ITO/PPEPPO/Al (b), and ITO/blend of Poly(PPV-N-hexylCvz)-PPEPPO/Al devices (c~f). As can be seen in Fig. 3(b), the device comprising a PPEPPO film exhibited a clearly higher threshold voltage of above 30V and did not function at all or exhibited minimal light output at high voltage. On the other hand, the turn-on voltage was 5V for the ITO/Poly(PPV-N-hexylCvz)/Al device (a). In the blend polymer devices, there was an increasing tendency in the turn-on voltage with the increasing the portion of PPEPPO.

A color of EL emission was changed with the blend ratio of Poly(PPV-N-hexylCvz) and PPEPPO. Figure 4 shows EL spectra of the blend of Poly(PPV-N-hexylCvz) and PPEPPO. The emitted light from

EL device of Poly(PPV-N-hexylCvz) (a) was yellowish green showing maximum light emitting peak at 533 nm. According to the increase of PPEPPO ratio, the EL emission peaks are blue-shifted about 40~70 nm compared to Poly(PPV-N-hexylCvz) and it was found that an EL efficiency of the blend was markedly increased, which is more than that of Poly(PPV-N-hexylCvz) itself. When the blend ratio was 50:50, the emission was green color. However, as the increase of PPEPPO content up to 83%, blue emission was observed. When the blend ratio was 9:91, the maximum EL peak at 461 nm and the maximum EL efficiency were observed. It was believed that the oxadiazole group of PPEPPO functioned as an electron transporting material, so that the recombination efficiency was raised due to the appropriate balance of hole and electron. In addition, the dilution effect was also worked for the EL efficiency.

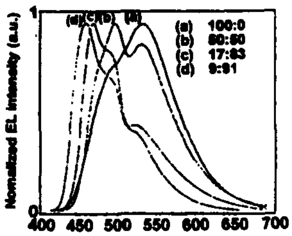

FIGURE 4 EL spectra of the blend of Poly(PPV-N-hexylCvz) and PPEPPO

CONCLUSIONS

The color tunable polymeric EL devices have been demonstrated using blends with Poly(PPV-N-hexylCvz) and PPEPPO depending on weight ratio. The PL and EL emissions were contributed from the luminance of Poly(PPV-N-hexylCvz) even at low PPEPPO ratio. This probably results from the energy transfer in the exited state from PPEPPO to Poly(PPV-N-hexylCvz). The optimal blend ratio of 9/91 [Poly(PPV-N-hexylCvz)/PPEPPO] for the maximum EL efficiency output was obtained. As the ratio of PPEPPO was increased from 50 to 83 %, the emission light was changed from green to blue color.

Acknowledgments. This work was supported by the Pusan National University.

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