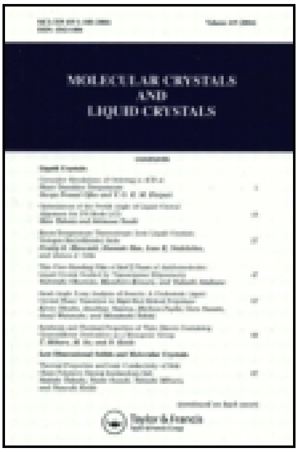

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Highly Efficient Electroluminescence Polymer Blend in Poly(p-phenylene vinylene) Derivatives

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Highly Efficient Electroluminescence Polymer Blend in Poly(p-phenylene vinylene) Derivatives

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Asymmetric and color tunable polymer blend systems from poly[2-(3'-dimethylalkylsilylphenyl)-1,4-phenylene vinylene] (m-SiPhPPV) and MEH-PPV were characterized. The maximum absorption (UV) and photoluminescence (PL) peaks of the blending system were proportional to the their blending ratios. The electroluminescence (EL) spectra with various blending ratios of the m-SiPhPPV and MEH-PPV were mainly contributed from the MEH-PPV part. The turn-on voltages for single-layer light emitting diodes (LEDs) are about 3V for m-SiPhPPV and MEH-PPV and 8V for blending systems.

Keywords: electroluminescence (EL); color tunable; polymer blend; poly(p-phenylene vinylene)

INTRODUCTION

Since the first report on the LEDs diodes using the poly(p-phenylene vinylene) [1] and their potential application to flat panel displays (FPDs), many research groups have been studied the π-conjugated polymers as an light emitting materials [2~4]. Polymer LEDs have the advantages of wide viewing angle, simple device fabrication, fast switching time, highly luminescent efficient, and color tunability by molecular architecture of the emitting materials with comparison to conventional liquid crystal displays (LCDs). In order to realize the full color PLED, it is necessary to develop the red, green and blue emission materials. The characteristics of a polymer LED are determined by the balanced injected charges, which is crucial in achieving high quantum efficiency. To solve these problems, the blended materials that contain different band gap of two emitting materials are used to form efficient single layer devices with color tuning and high quantum efficiency [5].

In this article, we reported the preparation and properties of the color tunable polymer blending systems with m-SiPhPPV and MEH-PPV as an emitting materials.

EXPERIMENTAL

Molecular structures of the m-SiPhPPV and MEH-PPV are shown in Fig. 1. The synthetic procedure of the m-SiPhPPV was described in the literature [6]. The mixing ratios of m-SiPhPPV and MEH-PPV were varied. In order to improve the interface between indium-tin oxide (ITO) and emitting layer, poly[3,4-dioxy ethylenethiophene] (PEDOT) doped with polystyrene sulfonate (PSS) in aqueous solution was spin-coated onto the ITO surface and dried for 5 min at 110°C to remove the residual solvent. The emitting layer was prepared by spin-coating the polymer mixture solution containing 1.5 wt% in THF onto ITO coated glass substrate with the thickness of about 100 nm and evaporated the solvent in a vacuum desicator at 50°C for 1 hr. The aluminum electrode about 200 nm was deposited on the top of the polymer film through a mask by vacuum evaporation at pressure below 4 x 10^{-6} Torr, yielding active areas of 4 mm^2.

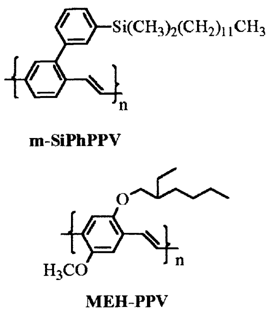

FIGURE 1. Molecular structure of m-SiPhPPV and MEH-PPV

RESULTS AND DISCUSSION

The polymers, m-SiPhPPV and MEH-PPV, were highly soluble in common organic solvents and thus defect-free uniform polymer thin films were easily formed onto the ITO coated glass substrate. Fig. 2

shows the UV-vis absorption spectra of m-SiPhPPV, MEH-PPV and their blend systems. Maximum absorption and band gap of m-SiPhPPV and MEH-PPV are shown at 450 nm, 2.31 eV and 560 nm, 2.10 eV, respectively. The band gap of m-SiPhPPV is larger than that of MEH-PPV. Absorption peaks of the polymer blends are located at 450 nm and 560 nm due to the two pure components of m-SiPhPPV and MEH-PPV, but maximum absorption peaks were varied by their weight fraction on the polymer blending systems.

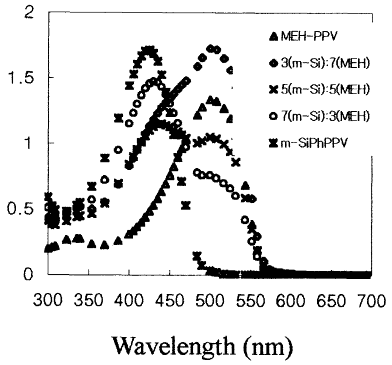

FIGURE 2. UV-vis absorption spectra of m-SiPhPPV, MEH-PPV and their blending systems

The PL spectra of m-SiPhPPV, MEH-PPV and their blend systems with different weight ratio of m-SiPhPPV and MEH-PPV are shown in Fig. 3. The emission spectra were obtained using maximum absorption wavelength of the corresponding blending systems. As shown in Fig. 3, the maximum PL peak shifts from that of m-SiPhPPV to that of MEH-PPV with the increasing the MEH-PPV part. From these results, PL with various emission colors between green and orange-red can be obtained by controlling the weight ratio of m-SiPhPPV and MEH-PPV.

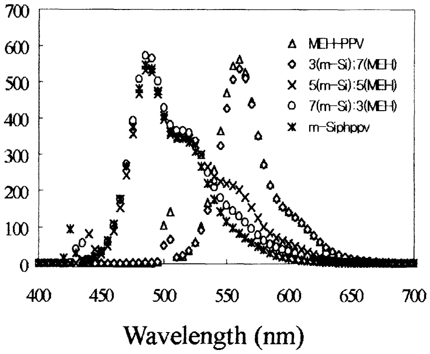

FIGURE 3. PL spectra of m-SiPhPPV, MEH-PPV and their blending systems

Fig. 4 shows the voltage-current (V-I) characteristics of an ITO/PEDOT/m-SiPhPPV/Al (a), ITO/PEDOT/MEH-PPV/Al (b), and ITO/PEDOT/blend of m-SiPhPPV-MEH-PPV/Al devices (c ~ e). Turn-on voltage of the devices comprising a polymer mixture is higher than that of m-SiPhPPV and MEH-PPV. The higher turn-on voltage of the polymer mixture may be attributed to the micro-domains in polymer matrix, which is difficult to identify the naked eyes. However, the current density of the polymer mixture is higher than that of m-SiPhPPV and MEH-PPV. EL spectra was measured from EL devices with PEDOT:PSS as a hole injection layer and utilizing the m-SiPhPPV, MEH-PPV and their polymer mixture at various weight ratios as an emitting layer. The EL spectra of the blending systems are almost identical to that of MEH-PPV even at lower molar concentration of MEH-PPV. This may be due to the energy transfer from excited m-SiPhPPV as an energy donor to MEH-PPV as an electron acceptor.

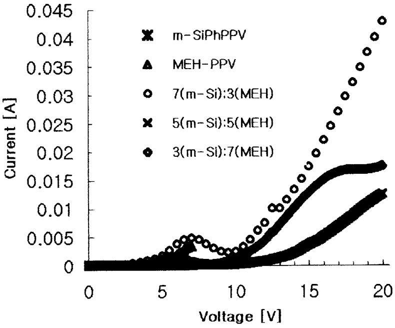

FIGURE 4. I-V characteristics of ITO/PEDOT/Polymer/Al devices

CONCLUSIONS

Asymmetric light emitting polymer containing bulky alkylsilphenyl substitutent into the phenylene vinylene backbone was synthesized by Gilch polymerization. The maximum absorption and PL peaks of the blending systems were dependent on the composition ratios of the m-SiPhPPV and MEH-PPV. However, EL emission was mainly contributed from the luminance of MEH-PPV, which was attributed to the efficient energy transfer from m-SiPhPPV to MEH-PPV.

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