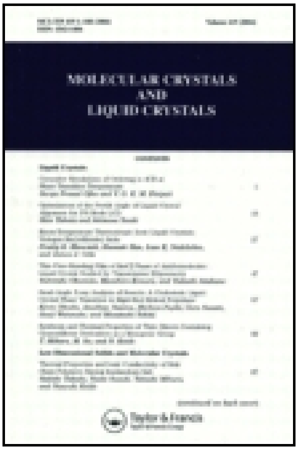

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Electroluminescent Properties of Polyurethane Derivative with Stilbene on the Side Chain

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Electroluminescent Properties of Polyurethane Derivative with Stilbene on the Side Chain

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Four kinds of organic electroluminescent devices (OELDs) were prepared. Two single-layer OELDs using polyurethane (PU) film (130nm) or PU:TPD (80:20 wt %, 130nm) were spin-coated on ITO substrate. Two double-layer OELDs were also prepared, using two single-layer then vacuum-sublimed Alq3 film (20nm) and Mg:Ag alloy layer as a cathode. Luminance-current density relationships in the single-layer and double-layer devices were discussed. Four kinds of OELDs exhibit strong electroluminescence (EL) in the green spectral region.

Keywords: organic electroluminescent devices (OELDs); polyurethane (PU)

INTRODUCTION

Since the demonstration of high-performance EL devices made of multi-layers of vacuum-sublimed dye films by Tang and VanSlyke [1], much progress has been made in the research and development of EL devices using molecular materials. A variety of molecular materials such as vacuum-sublimed dyes [2], fully π-conjugated polymers [3], polymers with chromophores in skeletal chains, or on side chains [4], and polymer-dispersed dyes [5] can be used for EL devices. Electroluminescence (EL) based on organic thin layers is one of the most promising next-generation flat panel display technology [6], The aim of this work is to investigate the electroluminescent properties of polyurethane derivative with stilbene on the side chain.

EXPERIMENTAL

Materials

In our previous paper [7], the synthesis of polyurethane with stilbene dye pendant was described. For a hole transport material, 4, 4'-bis(3-methylphenylphenylamino)biphenyl (TPD) was used. TPD and Alq3, as a hole transport material and an electron transport material, respectively, were synthesized as described in the literature [8]. Figure 1 illustrates the chemical structures used in this study.

Fabrication and Evaluation of EL Devices

Two single-layer OELDs were prepared, in which PU film (130nm) as an emitter layer or PU:TPD (80:20 wt %, 130nm) with a hole transport material TPD included in the emitter layer was spin-coated on well cleaned ITO substrate from a tetrahydrofuran solution and dried at room temperature for about one hour. Two double-layer OELDs were also prepared, in which two single-layer then vacuum-sublimed Alq3 film (20nm) as an electron transport layer and Mg:Ag alloy layer as a cathode were formed by using a standard vacuum-vapor deposition procedure. In the case of double-layer devices, a 20-nm-thick Alq3 layer was formed before the deposition of the Mg:Ag cathode.

RESULTS AND DISCUSSION

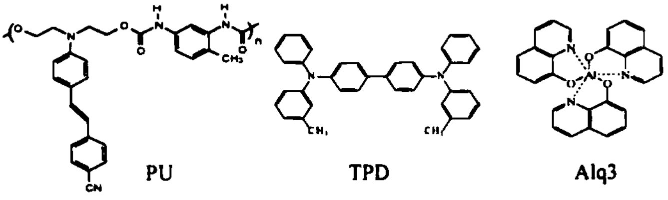

FIGURE 1. Chemical structures

Figure 2 shows the current density and the luminance relationships in the two PU single-layer and two double-layer devices. In the case of PU single-layer device, a luminance of approximately 50 cd/m^2 was observed at the maximum current density of 100 mA/cm^2, in which the quantum efficiency was calculated to be 0.033%. In the case of TPD-dispersed PU single-layer device, a luminance of approximately 150 cd/m^2 was observed at the maximum current density of 200 mA/cm^2. From the comparison of luminance (L) - current density (J) - voltage (V) relationships between the two devices, we found that the luminance of the TPD-dispersed PU single-layer device was about 2 times higher than that of the PU single-layer device at 100 mA/cm^2. These results thus imply that the TPD shows effective hole transport materials in TPD-dispersed PU single-layer device.

We show similar L-J-V relationships in two double layer devices. When the Alq3 layer was added to the PU layer device, a luminance of approximately 50 cd/m^2 was observed at the maximum current density of 60 mA/cm^2. When the Alq3 layer was added to the TPD-dispersed PU layer device, a luminance of approximately 450 cd/m^2 was observed at the maximum current density of 170 mA/cm^2. This large difference due to the introduction of the TPD was also observed in the case of the latter device.

In conclusion, it should be noted that about 10-fold increase of the maximum luminance was found when the Alq3 layer was added to the TPD-dispersed PU layer device, whereas when the Alq3 layer was

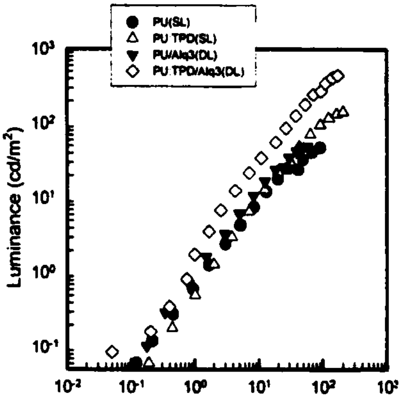

FIGURE 2. Luminance-current densit relationships single-layer (SL) and TPD dispersed PU double -layer(DL) devices.

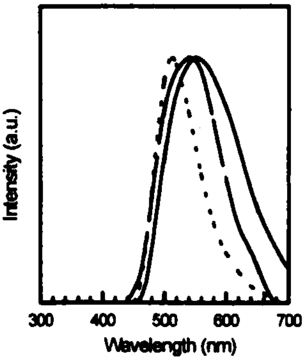

FIGURE 3. EL emission spectra for a devic with ITO/PU/MgAg (solid line) and ITO/PU:TPD/Alq3/MgAg(dashed line) and P spectrum of spin-coated PU films (dotted line)

added to the PU layer device without TPD, maximum luminance was almost same as that of the PU single layer device. The emission spectrum from the ITO/PU/Alq3/Mg:Ag device was almost the same as that of the ITO/PU/Mg:Ag device and thus it was confirmed that the PU layer behaves as emitting layer and the Alq3 layer takes the roles of electron transport and emission (Figure 3).

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