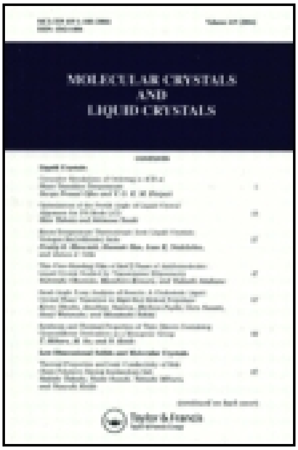

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Polymeric Light Emitting Devices Utilizing Poly(phenylene oligothiophene) Derivatives

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Polymeric Light Emitting Devices Utilizing Poly(phenylene oligothiophene) Derivatives

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Abstract Highly quantum efficient and multi-colorable electroluminescent (EL) devices has been realized by utilizing poly((1-dodecyloxy-4-methyl-1,3-phenylene)(2,5''-terthienylene)) (*m*PTTh polymer) as an emissive layer and tris(8-hydroxyquinoline) aluminum (Alq_3) as an electron transport layer. EL color is changed from orange to geenish orange depending on the thickness of Alq_3 layer. An Alq_3 layer in device acts as an hole blocking electron transport layer and an emissive layer as a function of the thickness of Alq_3 layer.

Keywords: polymer light emitting devices, polymer/organic heterostructure,

INTRODUCTION

Since electroluminescence (EL) from thin film of the π-conjugated polymer was first demonstrated [1], the light emitting devices (LEDs) utilizing π-conjugated organic molecules or polymers are one of the most promising next-generation flat panel display and light emitting diodes. Furthermore, heterostructure device combining the emissive layer and the charge transport layer is one of the ways to improve the quantum efficiency [2].

In this paper, we studied the EL and the electrical properties of the device made from the polythiophene containing *m*-phenylene block in the backbone. Multicolored light emission from heterostructure device was obtained.

EXPERIMENTAL

Single and double layer devices were fabricated with mPTTh polymer and tris(8-hydroxyquinoline) aluminum (Alq_3) as an emissive layer and an electron transport layer, respectively. Synthetic procedures and molecular properties of the mPTTh polymer were shown in detail in reference [3]. Details of the device fabrication processes and the optical and electrical measurements were described elsewhere [4].

RESULTS AND DISCUSSIONS

Figure 1 shows the normalized photoluminescence (PL) spectra (a) and EL spectral change (b) of the devices made from mPTTh polymer and Alq_3 as a function of the Alq_3 layer thickness. The PL peaks at 584 nm, and 523 nm originate from the pristine mPTTh polymer and Alq_3, respectively. The PL emission peaks at 523 nm increases with the Alq_3 layer thickness and two peaks became apparent with almost same intensity for Alq_3 layer thickness of 15 nm. For the devices with thicker Alq_3 layer, the PL emission from Alq_3 layer becomes dominant. However, EL spectra show a different behaviour.

As shown in Figure 1b, the emission peaks at 584 nm and 630 nm correspond to the pristine mPTTh polymer. The EL emission intensity at 525 nm corresponding to Alq_3 layer is also enhanced with the increase in Alq_3

thickness. However, in contrast to PL, the emission intensity from Alq_3 layer does not appear up to the Alq_3 layer thickness of 30 nm. The emission color changes from orange to greenish orange for the device with Alq_3 layer thickness of 50 nm. However, we did not find the color tunablity in any device depending on the various electric field. These results suggest that the Alq_3 layer may act not only as a hole-blocking electron transport layer but also an emitter layer when the Alq_3 layer becomes thick. We expect the recombination zone is extended from the mPTTh layer near to the mPTTh - Alq_3 interface to the Alq_3 layer by the exciton diffusion into Alq_3 layer [5].

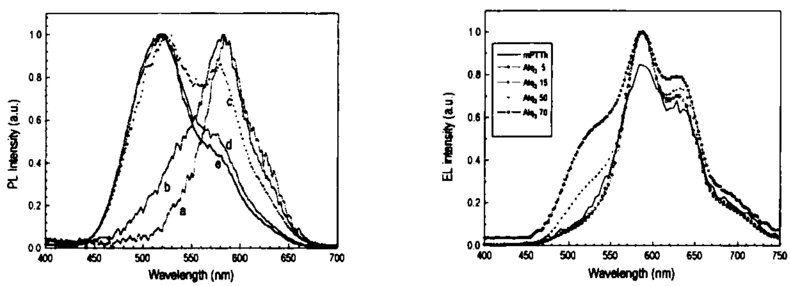

FIGURE 1. Normalized PL (left) and EL spectra (right) of the heterostructure devices as a function of Alq_3 layer thickness. The spectra a, b, c, d, and e correspond to the devices with the Alq_3 thickness of 0, 5, 15, 30, and 50 nm.

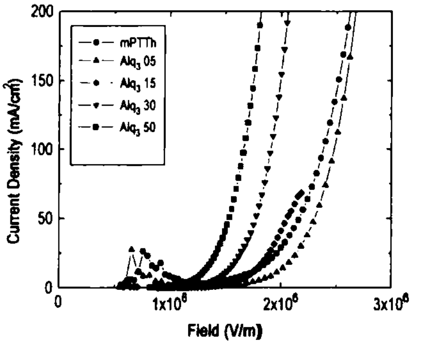

Figure 2. Current density - electric field curves for the heterostructure devices as a function of Alq_3 layer thickness. Alq_3 05 stands for the device of ITO/mPTTh/Alq_3(5nm)/Al structure.

Figure 2 shows the current density - electric field characteristic curves of heterostructure devices. As shown in Figure 2, the current starts to flow at lower electric field with the increase of Alq_3 layer thickness. According to the Fowler-Nordheim plots of the devices (not shown here), the slopes of linear portion of the curves become smaller for the thicker devices, which means the energy barrier for the carrier injection getting smaller. For the same electric field, the current density is large in the case of thicker device. The more luminescence comes out as the Alq_3 layer thickness increases. External quantum efficiency for the ITO/mPTTh/Alq_3 (30 nm) /Al device is 3000 times higher than that of the mPTTh single layer device. These suggest that Alq_3 assists the carrier injection and/or the space-charge build up more efficiently in the thick device.

CONCLUSIONS

Highly quantum efficient and multi-colorable EL devices were fabricated utilizing mPTTh polymer. Depending on the thickness of Alq_3 layer, the EL intensity increased and emission color changed from orange to geenish orange. Alq_3 layer assists the carrier injection and/or the space-charge build up more efficiently in heterostructure device.

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