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Electroluminescent Characteristics of Heterostructured Device with PPV Derivative and Tris(8-hydroxyquinoline) aluminum

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Abstract The electroluminescent characteristics of polymer/organic heterostructured device that fabricated with poly(2-methoxy-5-(2'-ethyl-hexyloxy)-1,4-phenylene vinylene) (MEH-PPV) and tris(8-hydroxyquinoline) aluminum (Alq3) is studied. The electroluminescent property of MEH-PPV/Alq3 device shows high luminescence with small current flow. The low molecular weight organic film that is formed on the emissive polymer acts as a hole blocking layer. The current limited structure of polymer/organic electroluminescent device is suggested and discussed to reduce the effect of Joule heat caused by the large current flow.

Keywords: electroluminescent; polymer/organic heterostructure

INTRODUCTION

There has been extensive research in polymer or organic electroluminescent(EL) device since the discovery of EL in the π-conjugated polymer[1, 2]. The EL devices with polymer and low molecular weight organic materials are promising for the application to the future flat panel display because of their advantages such as possibility of the flexible display, high luminescence and low power consumption, and so on.[3] One of the important

issue to commercialize the polymer or organic EL device is the device stability.[4] Among the various degradation sources, the Joule heat can not be eliminated by encapsulation of the device. In this study, we have tried to reduce the current flow in the polymer EL device by using organic hole blocking layer.

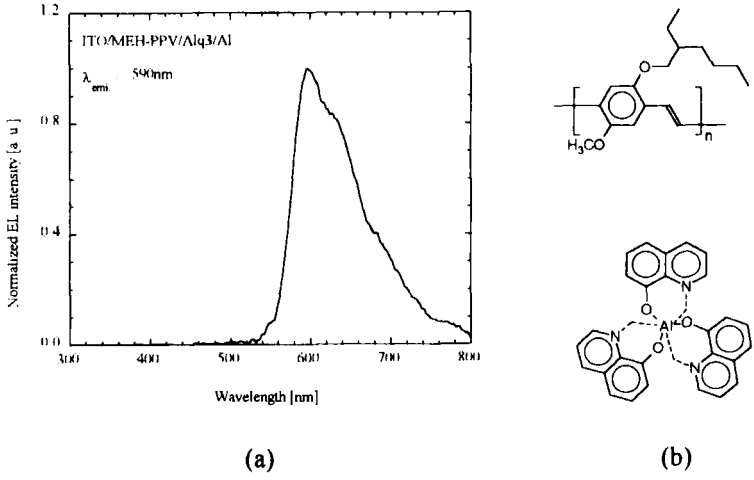
EXPERIMENTAL DETAILS

Poly(2-methoxy-5-(2'-ethyl-hexyloxy)-1,4-phenylene vinylene) (MEH-PPV) was spin coated for emissive layer onto the cleaned ITO glass substrate. The tris(8-hydroxyquinoline) aluminum (Alq3) for organic hole blocking layer was deposited onto the MEH-PPV film with the vacuum sublimation technique. Vacuum pressure was maintained in the range of 10^{-7} torr during the whole sublimation process and the deposition rate was kept within 1~2 Å/sec. The aluminum cathode was formed after the organic layer deposition by the vacuum evaporation with the thickness of 1000 Å. The EL spectra and current-voltage-luminescence(I-V-L) characteristics were measured to figure out the EL properties of the devices. Details in the fabrications and the measurements of the device were described elsewhere.[5, 6]

RESULTS AND DISCUSSIONS

Figure 1 represents the chemical structures of the materials used in this study and the EL spectrum observed for MEH-PPV/Alq3 heterostructured device. The emission maximum is appeared at the wavelength of 590nm and this emission comes from the MEH-PPV polymer layer. This result indicates that the Alq3 layer merely helps the electron injection into the emissive polymer through blocking the hole transportation at the interface between MEH-PPV

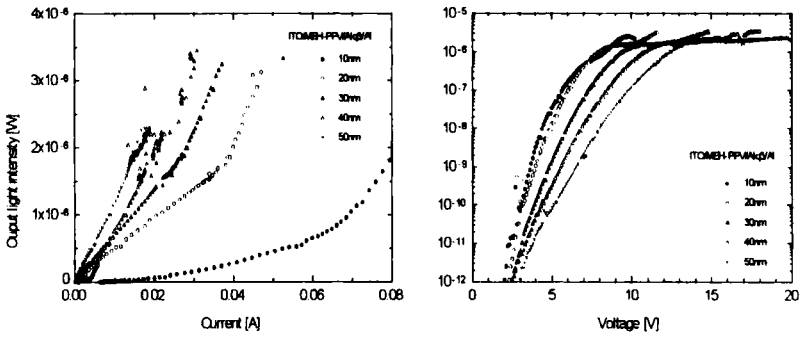
and Alq3 layer.



(a) (b)

FIGURE 1. (a) Normalized electroluminescent spectra of polymer/organic heterostructured device. (b) The chemical structures of MEH-PPV and Alq3.

Luminescence-current(L-I) and luminescence-voltage(L-V) characteristics of the MEH-PPV/Alq3 structured electroluminescent devices with various thickness of Alq3 hole blocking layer are shown in Figure 2. The current flow during the light emission is reduced with as the thickness of organic hole blocking layer increase. The MEH-PPV/Alq3 structured device shows quite high emission light intensity of 1 μW at low current less than ~9 mA when the thickness of Alq3 layer is 50nm. However, the turn-on voltage does not increase to that extent. The luminescence-voltage(L-V) characteristics shows that all the MEH-PPV/Alq3 devices turn the light on below 3 V though the thickness of Alq3 layer is increased from 10 nm to 50 nm.



(a) (b)

FIGURE 2. Luminescence-current(L-I), (a), and luminescence-voltage(L-V), (b), characteristics of ITO/MEH-PPV/Alq3/Al device with the thickness variation of Alq3.

CONCLUSIONS

We have studied the MEH-PPV/Alq3 heterostructured EL device to reduce the current flow and enhance the light emission. The highest light output at the lowest current flow is observed in the heterostructured EL device when the thickness of Alq3 layer is 50nm. From the results of our study, we suggest that the low current flow structure to reduce the effect of Joule heat can be established by the polymer/organic heterostructured EL device.

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