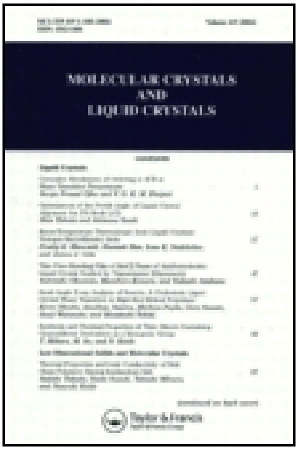

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Electroabsorption Measurement of Polymer Electroluminescent Devices with Insulating Layer

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Electroabsorption Measurement of Polymer Electroluminescent Devices with Insulating Layer

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We use the electroabsorption technique to measure the electric field in the emitting layer of ITO/MEHPPV/ionomer/Al light-emitting. Sodium sulfonated polystyrene (SSPS) was used as the ionomer. It is observed that the built-in potential in the emitting layer is lowered when the ionomer layer is inserted. On the contrary, the current density increases with the ionomer layers. These results indicate that the ionomer enhances the electron injection from the cathode to improve the balanced injection of electrons and holes into the light-emitting devices. Therefore, the quantum efficiency increases significantly in the EL device with the ionomer layer.

Keywords: insulating layer; electroabsorption; ionomer; polymer LED

INTRODUCTION

Recently, insertion of a thin insulating layer such as PMMA, LiF and ionomer between an emitting layer and the cathode was demonstrated to improve significantly the quantum efficiency of polymer EL devices.[1,2] However, the mechanism for the enhancement is not clear yet. Investigation of the electric field in the emitting layer can give some clue on the mechanism combined with the current-voltageluminescence data. In this work, we adopted the electroabsorption technique to measure the electric field in the light-emitting devices with insulating layer of various thicknesses.

EXPERIMENTAL

The devices were formed on glass substrates coated with ITO. Insulating material was used as sodium sulfonated polystyrene (SSPS), which is one of the ionomers. Four different polymer light-emitting devices of MEHPPV are fabricated on indium-tin oxide (ITO) coated glass substrates; a single layer structure device of ITO/MEHPPV/Al, and three two-layer ITO/MEHPPV/SSPS/Al. The thickness of the SSPS was varied between 12 to 22 nm, and the thickness of the MEHPPV was about 100 nm. Al cathode (200 nm) was evaporated.

The electroabsorption measurements were performed in a reflection geometry. Monochromatized light at a fixed wavelength at around 576 nm is focused on the device. Reflection configuration was adopted and a tungsten lamp was used for the light source.[3] A photomultiplier and a lock-in amplifier were used to detect the modulated light. The DC bias was scanned to study the dependence of EA signal.

RESULTS AND DISCUSSION

Current – voltage characteristics of the EL devices under forward bias are shown in Fig.1. It shows that the ITO/MEHPPV/SSPS/Al devices are turned on at lower bias voltage compared with the corresponding

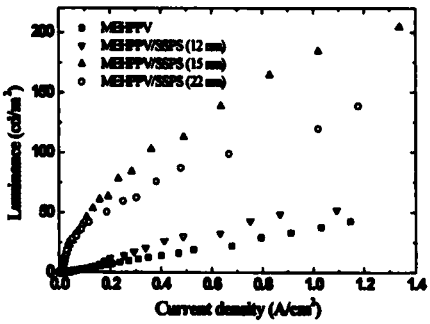

FIGURE 1. Current vs. voltage characteristics of the devices.

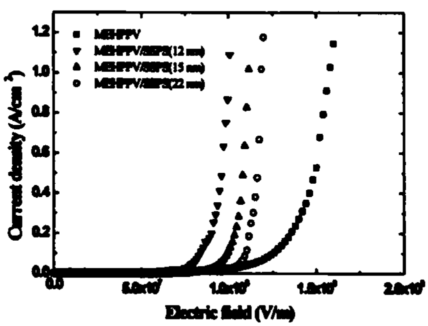

FIGURE 2. Luminance vs. current density characteristics.

MEHPPV single layer device. The current density at a certain electric field decreases as the thickness of SSPS increases. The dependence of the emission intensity on the injected current is shown in Fig.2 for different thickness of SSPS. The quantum efficiency and the luminance increase up to 15 nm and decrease as the thickness of SSPS increases further.

Fig.3 is a plot of the electroabsorption signal as a function of DC bias for the four devices. The electroabsorption signal from ITO/MEHPPV/SSPS/Al at a certain bias voltage is lower than that from

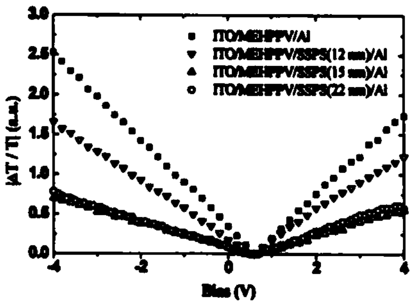

FIGURE 3. Electroabsorption response as a function of bias.

ITO/MEHPPV/Al. As the thickness of insulating layer is getting thicker, the electroabsorption signal becomes smaller (low electric field). It is interesting to note that the lower electric field in the MEHPPV layer in the devices with the ionomer layer results in higher current density than the ITO/MEHPPV/Al device. This fact can be understood by considering the electron current in the device. If both electrons and holes appear in the MEHPPV layer, the average electric field is lowered because of the charge compensation. On the contrary, the current increases because the current is a sum of hole and electron currents. The current increase by the electron current is supported by the enhancement of light emission in the ITO/MEHPPV/SSPS/Al device. This implies ionomer layers help to enhance the electron injection by some way in the polymer LED.

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