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Hyunjoo Park [a], Hyuntaek Lim [a], Youngkyoo Kim [b], Won Jei Cho [a] & Chang Sik Ha [a]

[a] Dept. of Polym. Sci. and Eng., Pusan Nat. Univ., Pusan, 609-735, Korea

[b] Electronic Materials Research Lab., Institute for Advanced Engineering, Daewoo Group, Yongin P.O.Box 25, Kyonggi-do, 449-800, Korea

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Organic Electroluminescence of Perylene-dispersed Polyimide Thin Film Device

HYUNJOO PARK[a], HYUNTAEK LIM[a], YOUNGKYOO KIM[a,b], WON JEI CHO[a], and CHANG SIK HA*[a]
[a]Dept. of Polym. Sci. and Eng., Pusan Nat. Univ., Pusan 609-735, Korea; [b]Electronic Materials Research Lab., Institute for Advanced Engineering, Daewoo Group, Yongin P.O.Box 25, Kyonggi-do 449-800, Korea

Two types of organic electroluminescent devices (OELDs) using perylene-dispersed polyimide as a lumophore were fabricated in the present study. One is single polymeric layer device in a structure of anode/perylene-dispersed polyimide/cathode, the other is double polymeric layer of anode/hole transport material-dispersed polyimide/perylene-dispersed polyimide/cathode. The turn-on voltage of the single and double layer devices was *ca.* 5 Vdc and 9 Vdc, respectively. The emission color was yellowish green. The double layer device was more efficient than the single layer device due to the balanced injection of holes and electrons in spite of the relatively high driving voltage.

Keywords: organic electroluminescent device (OELD), perylene, lumophore, polyimide, single polymeric layer, double polymeric layer.

INTRODUCTION

Organic electroluminescent devices (OELDs) utilizing fluorescent dyes[1,3] and conducting polymers[2,4] have attracted much attention because of their low driving voltage, easy processing of device, and mild control of emission band via incorporating various kinds of lumophores. Among the several methods for the preparation of OELD, it has been increasingly studied because it is easy and

economic to make the device by dispersing or doping lumophores in a polymer matrix[3,4]. However, it is of significance to select a binder polymer having good thermal stability and processibility for the durable device. In our previous reports, polyimides have been applied for the binder polymer[3] due to their outstanding characteristics such as high thermal stability and excellent film-forming property. In particular, fully aromatic polyimide such as poly(4,4'-oxydiphenylene pyromellitimide) (PMDA-ODA PI) is one of the best matrix polymers for the application of polymeric multilayer device because of its high chemical resistance[5].

In the present work, since perylene[6] is one of the thermally stable and efficient fluorescent dyes, perylene-dispersed soluble polyimide was used as a emission layer (EML) for a single polymeric layer device. For a double polymeric layer device, hole transport material (HTM)-dispersed insoluble polyimide and perylene-dispersed soluble polyimide were used as a hole-transporting layer (HTL) and EML, respectively.

EXPERIMENTAL

Chemical structures of the organic materials used in this work are shown in Figure 1. Perylene and *N,N'*-diphenyl-*N,N'*-di(m-tolyl)benzidine (TPD) were used as a lumophore and HTM, respectively. For a single polymeric layer device, perylene-dispersed poly(bisphenol A-*co*-4-nitrophthalic anhydride-*co*-1,3-phenylene diamine) (PEI) (perylene=30wt.%) was prepared by spin-coating the respective solution in chloroform on ITO-glass as an EML. For a double polymeric layer device, the TPD-dispersed poly(4,4'-oxydiphenylene pyromellitamic acid) (PMDA-ODA PAA) (TPD=30 wt.%) film on ITO-glass was firstly imidized above 200 °C. Secondly, perylene-dispersed PEI film was prepared on the previous HTL. Finally, aluminum as a cathode was vacuum deposited at 2×10^{-5} Torr for both of single and double layer devices.

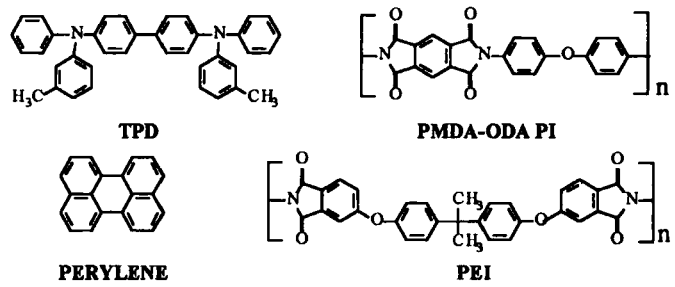

FIGURE 1 Chemical structures of organic and polymeric materials.

RESULTS AND DISCUSSION

The photoluminescent (PL) spectrum of TPD-dispersed PMDA-ODA PI /perylene-dispersed PEI double layer thin film is shown in Figure 2. The main peak at *ca.* 520 nm is corresponded to the perylene itself, which was proved in the very diluted solution. It is considered that the shoulder at 610 nm may be made by the excimer formation between perylene molecules at relatively high concentration of 30 wt.% in PEI.

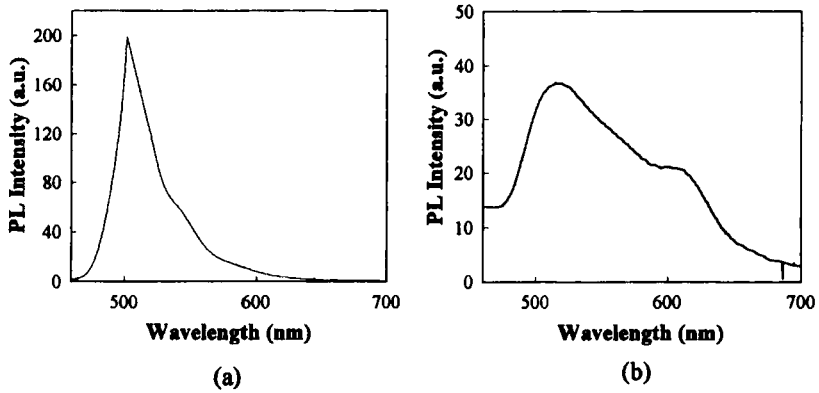

FIGURE 2 PL spectrum of diluted perylene solution(a) and TPD-dispersed PMDA-ODA PI / perylene-dispersed PEI double layer film(b). Excitation wavelength was 216nm

Figure 3 shows the current density-bias voltage-EL intensity characteristics of single and double polymeric layer devices. The current density of single layer device increases almost linearly below *ca.* 4 Vdc, while that of double layer device does below *ca.* 8 Vdc. This linear increment in current density is due to the ohmic leakage current. Above these take-off voltages, the exponential increase was occurred with the different current injection shape between single and double layer devices. The turn-on voltage of the single and double layer devices was *ca.* 5 Vdc and 9 Vdc, respectively. It is regarded that the presence of the TPD-dispersed PMDA-ODA PI layer affects the increase in turn-on voltage of the double layer device. Both of the devices emitted yellowish green light, but the brightness of double layer device was higher than that of single layer device. It means that the well balanced injection and recombination of holes and electrons were carried out in case of the double layer device.

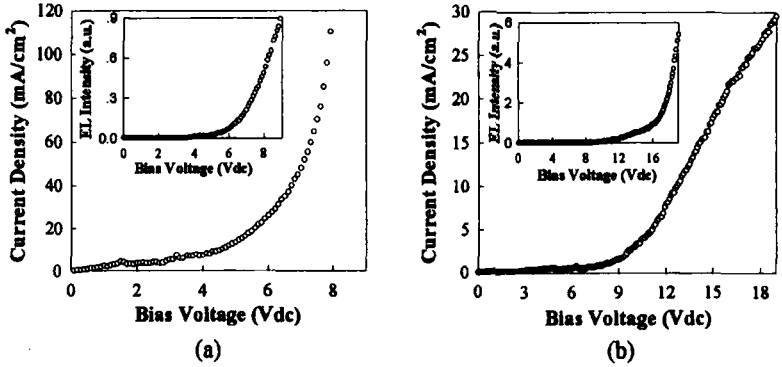

FIGURE 3 Current density-bias voltage-EL intensity characteristics of single polymeric layer device (a) and double polymeric layer device (b).

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