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Durability and Characteristics of Organic EL Device using Amorphous Materials as Hole Transporting Materials

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Amorphous molecular materials such as 1,3,5-tris(4-chlorophenyl phenylamino)benzene, *p*-ClTDAB and *p*-BrTDAB were synthesized and then organic electroluminescent (EL) devices using the amorphous compounds as hole transporting materials were fabricated. ITO/*p*-XTDAB (X=Cl or Br)/Alq_3/Al device emitted green light with the brightness of 1300 cd/m^2. Especially, it has been found that the durability and EL performance were improved by *p*-XTDAB compared to TDAB.

Keywords amorphous molecular materials; hole transporting materials; durability; EL performance

INTRODUCTION

A great improvement in orgnic EL device has been achieved by various approaches [1]. It has been reported that the structure of hole transporting material (HTM) plays an important role in improving EL efficiency. Especially, the optoeletrical properties of EL device are found to be significantly influenced by thermal and morphological stability of HTM [2].

In this study, we fabricated the organic EL device using the amorphous molecular materials with high glass transition temperature as HTMs and investigated the effects of the amorphous property on EL

characteristics.

MATERIALS AND EXPERIMENTAL

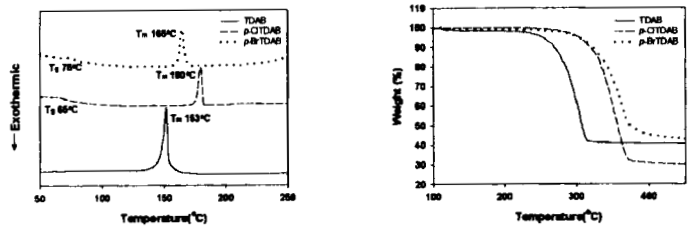
p-XTDAB (X=Cl or Br) was synthesized by Ullmann reaction of 1,3,5-tris(phenylamino)benzene prepared with aniline and phloroglucinol and 4-chloroiodobenzene. The product was purified by column chromatography using silica gel and was identified as *p*-XTDAB through element analysis, and other spectroscopic measurements. Thermal stability and formation of glassy state were confirmed by TGA (TA instruments 2950 TGA), and DSC (Perkin Elmer DSC 7), respectively.

The *p*-XTDAB film as a hole transport layer was spin-casted from a monochlorobenzene solution onto the ITO coated glass. The speed of spin casting was about 2000 rpm. Alq_3 and Al were deposited by a ULVAC VPC-200F evaporator under the pressure below 1510^{-5} Torr. PL and EL spectra were obtained from the measurements of an Acton 300i spectrofluorometer. The morphology of *p*-XTDAB and TDAB were observed with an Auto Probe PSI AFM.

RESULTS AND DISCUSSION

DSC and TGA curves of TDAB and *p*-XTDAB (X=Cl or Br) were shown in Figure 1 (a) and (b), respectively. In the second heating of *p*-XTDAB compounds, a glass transition phenomenon was observed at 65~75 ℃. Especially, *p*-XTDAB with a heavier halogen atom showed high glass transition temperature due to the hinder of molecular motions. The amorphous molecular materials were thermally stable compared to

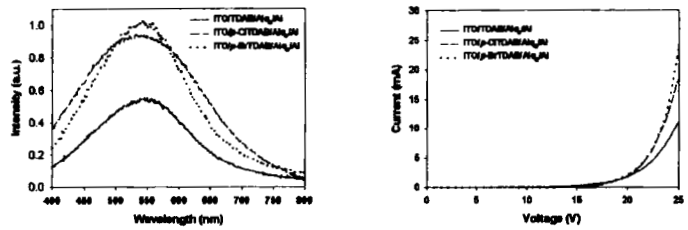
TDAB compound as shown in Figure 1 (b).



(a) (b)

FIGURE 1 (a) DSC and (b) TGA curves of TDAB and *p*-XTDAB.

Figure 2 showed the EL spectra and I-V characteristics of the EL cell consisting of ITO/*p*-XTDAB/Alq_3/Al. The EL cell using amorphous hole transporting material with high glass transition temperature exhibited high EL intensity. It may be argued that this behavior is mainly due to the high stability of glassy state and improvement of interface property.



(a) (b)

FIGURE 2 (a) EL spectra and (b) I-V characteristics of ITO/TDAB and *p*-XTDAB/Alq_3/Al.

Figure 3 showed the three-dimensional AFM images of TDAB and *p*-BrTDAB. The surface morphology of *p*-BrTDAB did not changed under the exposure to atmosphere for 24 h.

As shown in Figure 4, the durability of EL cell using amorphous materials for applied voltage was much higher than that of EL cell

using TDAB. Therefore, it can be concluded that amorphous hole transporting materials resulted in the easy of hole transport and higher thermal and morphological stability.

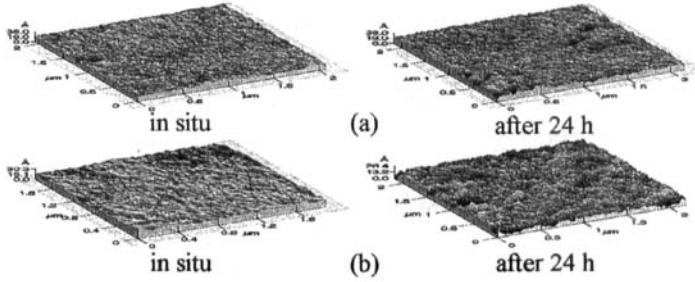


FIGURE 3 AFM images of (a) *p*-BrTDAB and (b) TDAB.

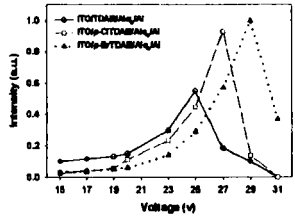


FIGURE 4 L-V characteristics of ITO/TDAB or *p*-XTDAB/Alq_3/Al.

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