Study on the electrical characteristics of organic light emitting devices using new hole transport materials

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Abstract

We have synthesized new hole transport materials(HTMs). Then we have fabricated structures of ITO/new HTM/Alq_3/EIL/Al. New HTM based devices have higher current density and lower turn-on voltage than TPD based devices. New HTMs have higher HOMO level than TPD. The new HTM based OLEDs have shown better current injection than the TPD based OLEDs, due to the lower injection barrier between ITO surface and HTM.

1. Introduction

Since Tang's first organic light emitting diodes(OLEDs) report[1], OELDs have received much attention in recent years because of their potential application in full color flat panel displays.[2]. Great progress has been made in improving the OLEDs performance such as improving charge injection, balancing the number of electrons, holes and separating the emission region from the metal contacts.

It has been reported that the hole injection can be improved by inserting a copper phthalocyanine (CuPc) between the HTL and the indium tin oxide (ITO) anode. The ITO/CuPc barrier is lowered because of the higher HOMO level of CuPc[3]. CuPc based devices have known to have adhesion morphology between ITO and HTL. However, because of Q-band of CuPc[4], CuPc couldn't be applied for full color OLEDs.

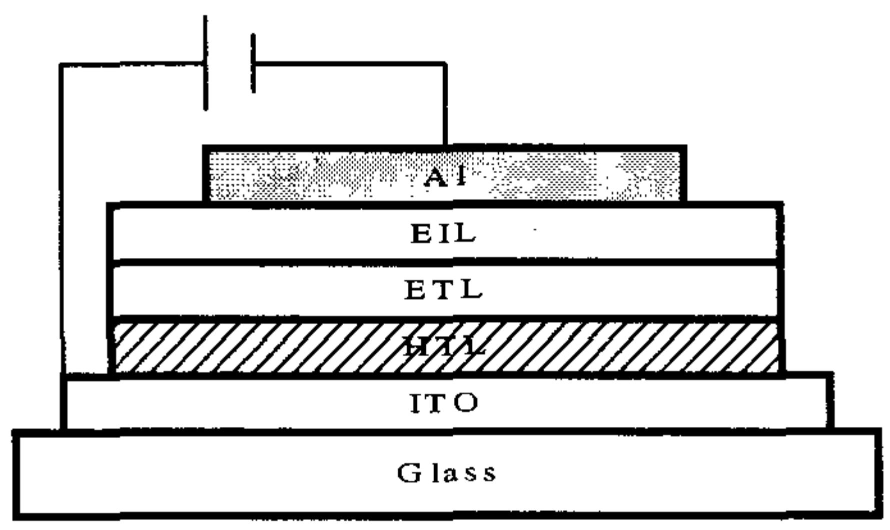

Figure 1. Structure of the EL devices

In this paper, we focused on the energy barrier of hole injection using new hole transport materials(HTMs) in the structure of an anode/HTM/Alq_3/EIL/cathode.

2. Experimental

OLEDs were fabricated by high vacuum (~10^{-6} torr) thermal deposition of organic materials onto the surface of an indium tin oxide (ITO, 30 Ω/ , 80 nm) coated glass substrate chemically cleaned using acetone, methanol, distillated water and isopropyl alcohol. A schematic diagram of this OLED along with the materials used to build the OLED is shown in Figure 1. The organic materials were deposited in the

(a)

(b)

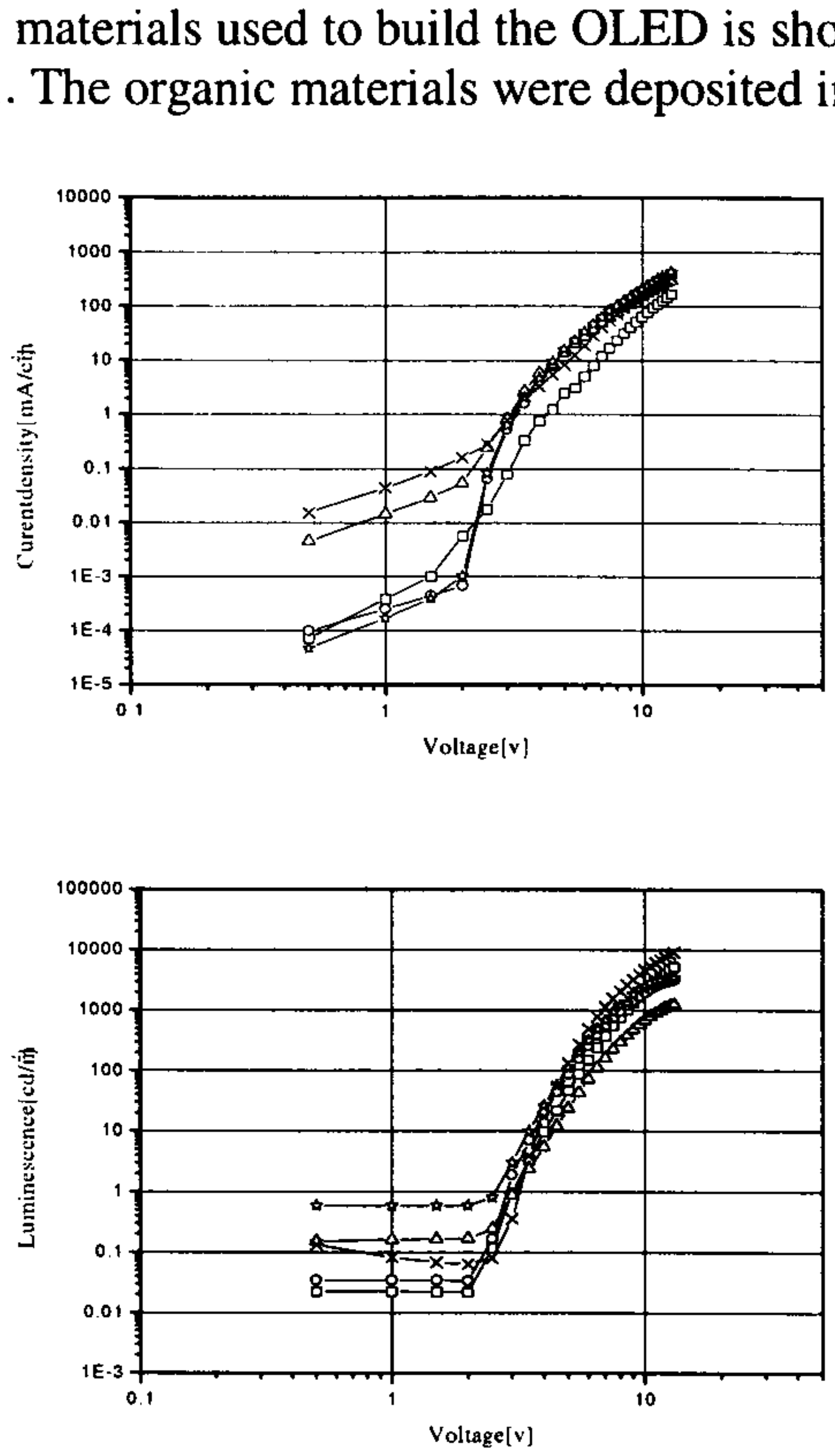

Figure 2. (a) Current density vs voltage characteristics, (b) Luminescence vs voltage for the devices used (□) TPD, (○) HTM 2(GDI 902), (□) HTM 3(GDI 903), (□) HTM 4 (GDI 904), (X) CuPc/TPD

following sequence: 40 nm of new hole transport materials was used as a hole transporting layer, followed by a 50 nm thick tris-(8-hydroxyquinoline) aluminum (Alq_3) used as an electron transporting and emitting layer. Finally a 1 nm thick electron injection material was deposited. The 150 nm of Al was deposited as a cathode. Deposition rate of organic materials was 1 ~ 2 Å/s and emitting area of OLEDs were 0.3 x 0.3 cm^2. All organic materials are supplied by Gracel Display Incorporation(GDI). The current-voltage-luminance (I-V-L) characteristics of OLEDs were measured with programmable electrometer (keithy 617), source measure unit (keithy 236) and Roper Scientific photodiode (SI440-UV). The OLEDs properties were measured with encapsulation.

3. Results and discussion

Figure 2-(a) shows the current density vs voltage characteristics of devices employing new hole transport materials(HTM). New HTM based devices have higher current density and lower turn on voltage(2.0V) than TPD and CuPc/TPD(2.4V) based devices. However from a Figure 2-(b), new HTM based devices has lower luminance compared to TPD based device. We think that it is due to the unbalance hole and electron injection, which leads to less effective exciton formation.

(a)

(b)

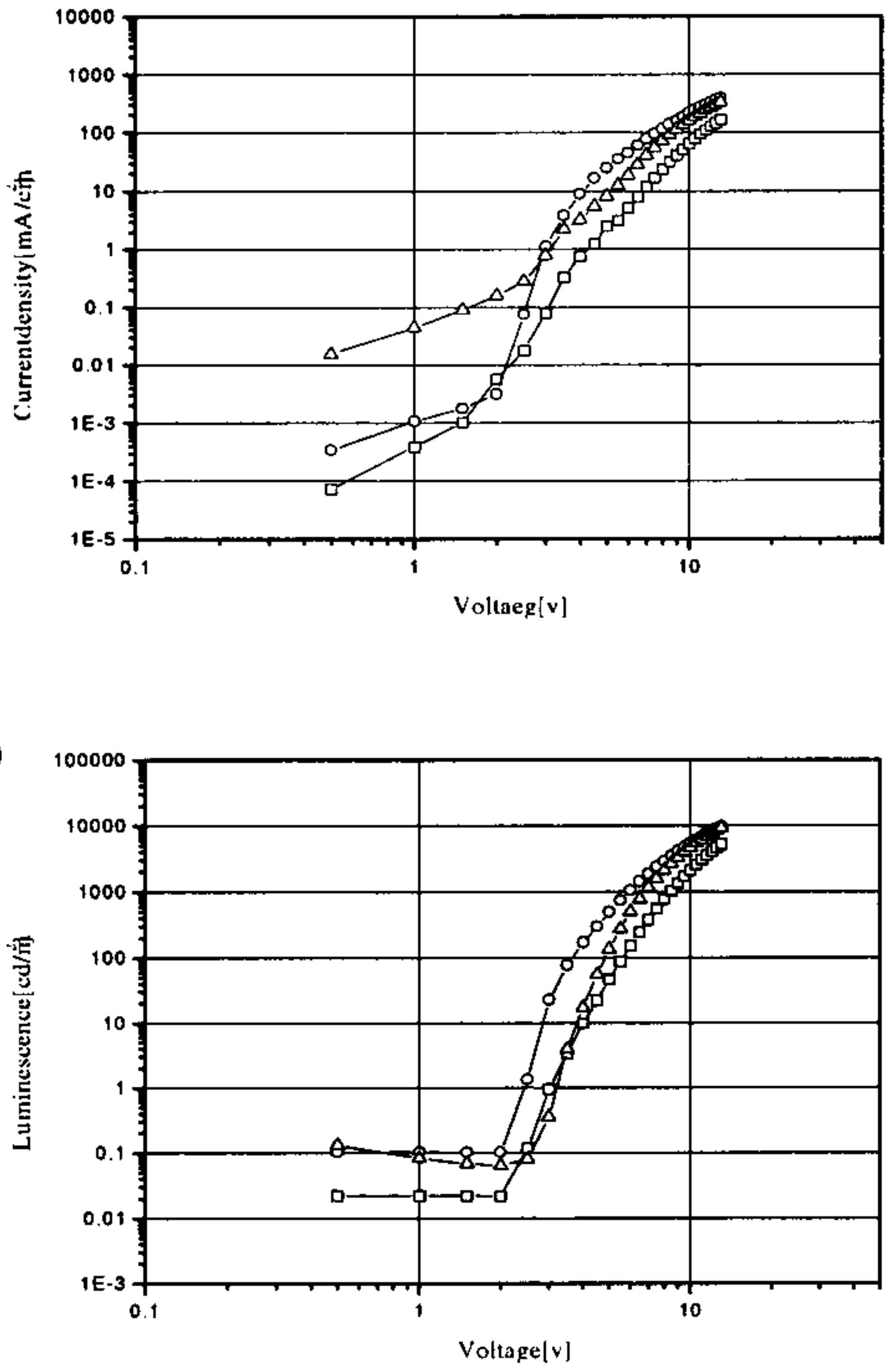

Figure 3. (a)Current density vs voltage characteristics, (b) Luminescence vs voltage for the devices used (□) TPD, (○), HIM 3(GDI903)/TPD, (□) CuPc/TPD

Figure 3-(a) shows the current density, voltage and luminance, voltage characteristics. New HIM based devices have significantly improved current density and luminance. OLEDs employing new HIM has lower operating voltage(3.6V) than CuPc/TPD based OLEDs(4.8V) at 100cd/m^2. The contact area of HTL on ITO is important factor in determining the hole injection[5].

So far, we have demonstrated the synthesis and the characterization of new HTM and HIM. New HIM based devices show lower turn-on voltage and higher luminance than CuPc based devices. It is considered that the enhanced performance of OLED with new HTM/HIM is caused by higher HOMO level.

4. Conclusion

We fabricated efficient OLEDs with new hole transport materials. New HTM based devices had improved electrical and optical characteristics due to higher HOMO level. Lower electroluminescence efficiency was observed for the device with a new HTM OLEDs. Therefore, higher efficiency is expected by simultaneously enhancing the electron injections.

Acknowledgments

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5. References

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