This article was downloaded by: [University of Haifa Library]

On: 20 August 2012, At: 10:39 Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH,

UK



# Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information: <a href="http://www.tandfonline.com/loi/gmcl19">http://www.tandfonline.com/loi/gmcl19</a>

# Polymeric Light Emitting Devices Utilizing Poly(phenylene oligothiophene) Derivatives

Lee-Mi Do <sup>a</sup> , Bong-Soo Kang <sup>b</sup> , Do-Hoon Hwang <sup>a</sup> , Kang-Hoon Choi <sup>a</sup> , Hyang-Mok Lee <sup>a</sup> , Song-Chul Shin <sup>b</sup> & Taehyoung Zyung <sup>a</sup>

Version of record first published: 04 Oct 2006

To cite this article: Lee-Mi Do, Bong-Soo Kang, Do-Hoon Hwang, Kang-Hoon Choi, Hyang-Mok Lee, Song-Chul Shin & Taehyoung Zyung (1998): Polymeric Light Emitting Devices Utilizing Poly(phenylene oligothiophene) Derivatives, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 316:1, 273-276

To link to this article: <a href="http://dx.doi.org/10.1080/10587259808044507">http://dx.doi.org/10.1080/10587259808044507</a>

<sup>&</sup>lt;sup>a</sup> Electronics and Telecommunications Research Institute, P. O. Box 106, Yusong, Taejon, 305-600, Korea

<sup>&</sup>lt;sup>b</sup> Department of Chemistry, Gyeonsang National University, Chinju, 660-701, Korea

## PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <a href="http://www.tandfonline.com/page/terms-and-conditions">http://www.tandfonline.com/page/terms-and-conditions</a>

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae, and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

© 1998 OPA (Overseas Publishers Association) N.V. Published by license under the Gordon and Breach Science Publishers imprint. Printed in India.

# Polymeric Light Emitting Devices Utilizing Poly(phenylene oligothiophene) Derivatives

LEE-MI DO, BONG-SOO KANG, DO-HOON HWANG, KANG-CHOI, HYANG-MOK LEE, HOON SONG-CHUL SHIN<sup>a</sup> TAEHYOUNG ZYUNG

Electronics and Telecommunications Research Institute, P. O. Box 106, Yusong, Taejon 305-600, Korea; \*Department of Chemistry, Gyeonsang National University, Chinju, 660-701, KOREA

Highly quantum efficient and multi-colorable electro-Abstract luminescent (EL) devices has been realized by utilizing poly((1dodecyloxy-4-methyl-1,3-phenylene)(2,5"-terthienylene)) (mPTTh polymer ) as an emissive layer and tris(8-hydroxyquinoline) aluminum (Alq<sub>3</sub>) as an electron transport layer. EL color is changed from orange to geenish orange depending on the thickness of Alq<sub>3</sub> layer. An Alq<sub>3</sub> layer in device acts as an hole blocking electron transport layer and an emissive layer as a function of the thickness of Alq<sub>3</sub> layer.

Keywords: polymer light emitting devices, polymer/organic heterostructure,

# INTRODUCTION

Downloaded by [University of Haifa Library] at 10:39 20 August 2012

Since electroluminescence (EL) from thin film of the  $\pi$ -conjugated polymer was first demonstrated [1], the light emitting devices (LEDs) utilizing  $\pi$ conjugated organic molecules or polymers are one of the most promising next-generation flat panel display and light emitting diodes. Furthermore,

heterostructure device combining the emissive layer and the charge transport layer is one of the ways to improve the quantum efficiency [2].

In this paper, we studied the EL and the electrical properties of the device made from the polythiophene containing *m*-phenylene block in the backbone. Multicolored light emission from heterostructure device was obtained.

#### **EXPERIMENTAL**

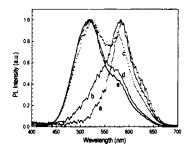
Single and double layer devices were fabricated with mPTTh polymer and tris(8-hydroxyquinoline) aluminum (Alq<sub>3</sub>) as an emissive layer and an electron transport layer, respectively. Synthetic procedures and molecular properties of the mPTTh polymer were shown in detail in reference [3]. Details of the device fabrication processes and the optical and electrical measurements were described elsewhere [4].

## RESULTS AND DISCUSSIONS

Figure 1 shows the normalized photoluminescence (PL) spectra (a) and EL spectral change (b) of the devices made from mPTTh polymer and Alq<sub>3</sub> as a function of the Alq<sub>3</sub> layer thickness. The PL peaks at 584 nm, and 523 nm originate from the pristine mPTTh polymer and Alq<sub>3</sub>, respectively. The PL emission peaks at 523 nm increases with the Alq<sub>3</sub> layer thickness and two peaks became apparent with almost same intensity for Alq<sub>3</sub> layer thickness of 15 nm. For the devices with thicker Alq<sub>3</sub> layer, the PL emission from Alq<sub>3</sub> layer becomes dominant. However, EL spectra show a different behaviour.

As shown in Figure 1b, the emission peaks at 584 nm and 630 nm correspond to the pristine mPTTh polymer. The EL emission intensity at 525 nm corresponding to Alq<sub>3</sub> layer is also enhanced with the increase in Alq<sub>3</sub>

thickness. However, in contrast to PL, the emission intensity from Alq<sub>3</sub> layer does not appear up to the Alq<sub>3</sub> layer thickness of 30 nm. The emission color changes from orange to greenish orange for the device with Alq<sub>3</sub> layer thickness of 50 nm. However, we did not find the color tunablity in any device depending on the various electric field. These results suggest that the Alq<sub>3</sub> layer may act not only as a hole-blocking electron transport layer but also an emitter layer when the Alq<sub>3</sub> layer becomes thick. We expect the recombination zone is extended from the mPTTh layer near to the mPTTh - Alq<sub>3</sub> interface to the Alq<sub>3</sub> layer by the exciton diffusion into Alq<sub>3</sub> layer [5].



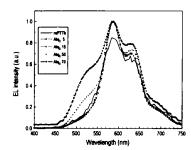


FIGURE 1. Normalized PL (left) and EL spectra (right) of the heterostructure devices as a function of Alq<sub>3</sub> layer thickness. The spectra a, b, c, d, and e correspond to the devices with the Alq<sub>3</sub> thickness of 0, 5, 15, 30, and 50 nm.

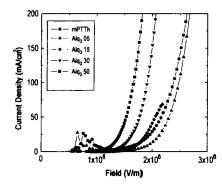


Figure 2. Current density - electric field curves for the heterostructure devices as a function of Alq<sub>3</sub> layer thickness. Alq<sub>3</sub> 05 stands for the device of ITO/mPTTh/Alq<sub>3</sub>(5nm)/Al structure.

Figure 2 shows the current density - electric field characteristic curves of heterostructure devices. As shown in Figure 2, the current starts to flow at lower electric field with the increase of Alq<sub>3</sub> layer thickness. According to the Fowler-Nordheim plots of the devices (not shown here), the slopes of linear portion of the curves become smaller for the thicker devices, which means the energy barrier for the carrier injection getting smaller. For the same electric field, the current density is large in the case of thicker device. The more luminescence comes out as the Alq<sub>3</sub> layer thickness increases. External quantum efficiency for the ITO/mPTTh/Alq<sub>3</sub> (30 nm) /Al device is 3000 times higher than that of the mPTTh single layer device. These suggest that Alq<sub>3</sub> assists the carrier injection and/or the space-charge build up more efficiently in the thick device.

# CONCLUSIONS

Highly quantum efficient and multi-colorable EL devices were fabricated utilizing mPTTh polymer. Depending on the thickness of Alq<sub>3</sub> layer, the EL intensity increased and emission color changed from orange to geenish orange. Alq<sub>3</sub> layer assists the carrier injection and/or the space-charge build up more efficiently in heterostructure device.

#### REFERENCES

- [1] J. H. Burroughes, D. D. C. Bradley, A. R. Brown, R. N. Marks, K. Mackay, R. H. Friend, P. L. Burns and A. B. Holmes, Nature 347, 539 (1990).
- [2] N. C. Greenham, S. C. Moratti, D. D. C. Bradley, R. H. Friend, and A. B. Holmes, Nature 365, 628 (1993).
- [3] B.S. Kang, M.-L. Seo, Y. S. Jun, C. K. Lee and S. C. Shin, J. C. S. Chem. Commun., 1167 (1996).
- [4] Taehyoung Zyung and Sang-Don Jung, ETRI Journal 18, 181 (1996).
- [5] C. W. Tang and S. A. VanSlyke, J. Appl. Phys. 65, 3610(1989).