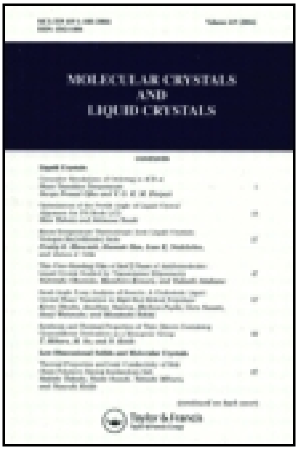


Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Effect of Joule Heat on the Performance of Organic Electroluminescence Device

Jeong-Woo Choi [a], Joo Sung Kim [a], Se Young Oh [a] & Won Hong Lee [a]

[a] Dept. of Chemical Engineering, Sogang University, C.P.O. BOX 1142, Seoul, 121-742, Korea

Version of record first published: 24 Sep 2006

To cite this article: Jeong-Woo Choi, Joo Sung Kim, Se Young Oh & Won Hong Lee (2001): Effect of Joule Heat on the Performance of Organic Electroluminescence Device, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 371:1, 285-288

To link to this article: http://dx.doi.org/10.1080/10587250108024742

Mol. Cryst. and Liq. Cryst., 2001, Vol. 371, pp. 285-288

Effect of Joule Heat on the Performance of Organic Electroluminescence Device

JEONG-WOO CHOI, JOO SUNG KIM, SE YOUNG OH and WON HONG LEE

Dept. of Chemical Engineering, Sogang University, C.P.O. BOX 1142, Seoul 121-742, Korea

In the electroluminescent (EL) device, the joule heat, which is caused by non-emissive site, is the crucial factors mainly affecting the degradation process of the organic electroluminescent device (OELDs). In this thesis, the effect of heat treatment to the polymer hole transport layer (PHTL) on the performance of the organic electroluminescent devices was investigated. Poly(9-vinylcarbazole) [PVK] was used as a PHTL. PHTL was coated onto ITO-coated glass substrate by spin coating method. OELDs were fabricated with the structure of ITO/ PHTL/ Emitting layer (Alq3)/ Electrode (Al), and PHTL were treated by heat. The different surface morphologies of PHTL were observed by atomic force microscopy (AFM) at the variation of exposure time and temperature. The degree of the PHTL degradation was increased as the exposure time and temperature were increased

Keywords: Organic electroluminescence device; Atomic Force Microscopy; Themal degradation;

INTRODUCTION

The first report of electroluminescence (EL) in organic materials was by Helfrich and Schneider[1] in 1965 when they applied 50-1000 V to millimeter-sized anthracene crystals and observed fluorescence. A variety of studies of the mechanism for transport and injection ensued, but the difficulty of single crystal growth and the large voltages required for macroscopic samples limited the practicality of such a scheme. Widespread interest in organic EL device was revived by the work of Tang, VanSlyke, and Chen[2] who fabricated analogous devices using thin (~100 nm) evaporated films of 8-hydroxyquinoline aluminum (Alq3) and low voltages (~10 V). Further attention was drawn to this possibility with the advent of similar devices fabricated by Burroughes *et al.*[3] based on the conjugated polymer polyparaphenylenevinylene (PPV) which could be formed via spin-casting from solution and subsequent thermal treatment. The development of a solution-processable precursor for PPV and solubilized conjugated polymer derivatives makes this a potentially attractive approach for simple EL devices fabrication.

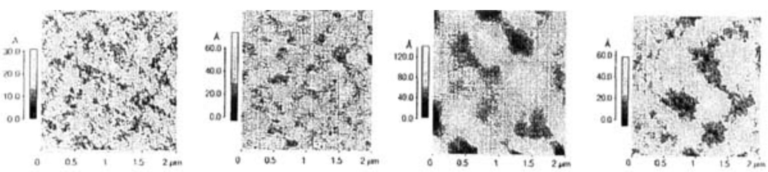
EXPERIMENTAL DETAILS

Tris(8-quinolinolato)alumnum (Alq3), used as light-emitting material, was purchased from Sigma chemical company (St. Louis, USA). Alq3 was purified by vacuum temperature gradient sublimation, in which the temperature was gradually increased to 180 ℃ over a periode of five days and the pressure was maintained at 10-7 torr. After this procedure, this material had good purity. Poly (9-vinylcarbazole) [PVK] was purchased from Sigma chemical company, were used as a polymer HTL. Al was used as cathode electrode and purchased from Sigma chemical company. The ITO-coated glass plates, which were used as anode electrode, were kindly obtained from Samsung Display Device Co. (Korea).

RESULTS AND DISCUSSION

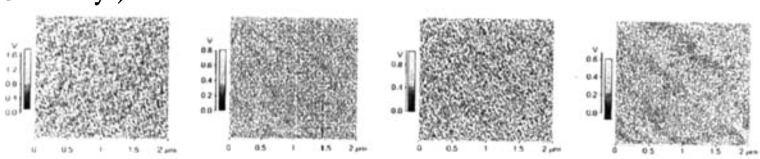
We investigated surface morphology changes of PVK thin films with

AFM and Friction force microscopy (FFM). FFM can detect the different friction of surface. In the case of the PVK thin films treated at 55 ℃ and 95 ℃, the special difference of friction force of thin films was not included in Fig. 2 and 4. If PVK thin film was partially extincted, clear difference in the detection of FFM would have been shown. But we could show that the extinction of PVK thin film had not occurred in Fig. 2 and 4, with partially. The quality of surface morphology became worse with increasing of degree of thermal treatment and time (Fig. 1, 3). The defection of PVK thin film strong in the characteristics of depth.



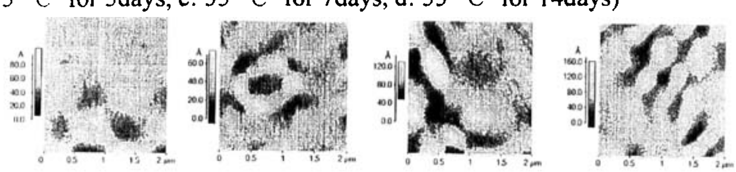
(a) (b) (c) (d)

FIGURE. 1 The changes of surface morphology of PVK thin-film (a: at 55 ℃ for 3days, b: 55 ℃ for 5days, c: 55 ℃ for 7days, d: 55 ℃ for 14days)



(a) (b) (c) (d)

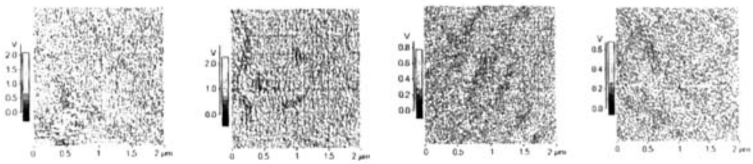
FIGURE. 2 FFM images of PVK thin-film (a: at 55 ℃ for 3days, b: 55 ℃ for 5days, c: 55 ℃ for 7days, d: 55 ℃ for 14days)



(a) (b) (c) (d)

FIGURE. 3 The changes of surface morphology of PVK thin-film (a: at 95 ℃ for 3days, b: 95 ℃ for 5days, c: 95 ℃ for 7days, d: 95 ℃

for 14days)



(a) (b) (c) (d)

FIGURE. 4 FFM images of PVK thin-film (a: at 95 ℃ for 3days, b: 95 ℃ for 5days, c: 95 ℃ for 7days, d: 95 ℃ for 14days)

When the operation time of OLEDs becomes longer, the local joule heat about 100℃ is cause by that. The local joule heat is cause by non-emissive site, which means non-effective hole-electron recombination. The external form of a thin film, the degradation of HTL morphology and tough morphology can be influenced by thermal treatment. These phenomena leaded diminution of effective interfacial area. In this thesis, voids are common morphological change of a thin film, which may result in serious yield and reliability problems in micro-electronic devices. From the point of view of device application, a morphological change such as the formation of many tiny voids in a film is serious problem in turn-on voltage and lifetime. The microscopic degradation of polymer will be unavoidable. But, in OELD, I think that cross-linking of polymer HTL will make improve microscopic degradation of polymer HTL. To clarify the thermal degradation below the glass transition temperature the void formation was more investigated.

References

[1] W. Helfrich *et. al.*, Phys. Rev. Lett. **14**, pp 229-231 (1965)
[2] C. W. Tang *et. al.*, Appl. Phys. Lett. **51**, pp 913-915 (1987)
[3] J. H. Burroughes *et. al.*, Nature(London) **347**, pp 539-541 (1990)