The effect of NPB morphology on OLEDs optoelectronic characteristics

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Abstract

NPB surface morphologies deposited on different temperature substrates were investigated using atomic force microscopy(AFM). It has been found that the NPB morphology turned from island morphology at high temperature(100℃) to grain morphology at room temperature. To characterize the effect of NPB surface morphology, the devices with the structure of Glass/ITO/NPB/Alq_3/Al were fabricated using NPB films deposited at different substrate temperature and their performances were compared.

1. Introduction

Organic light-emittig devices (OLEDs) have attracted considerable studies since its initial report by Tang and Van Slyke in 1987[1]. Small molecules based devices with NPB and tris(8-hydroxyquinoline) aluminum(Alq_3) have demonstrated luminescence higher than 1000cd/m^2 and operating lifetimes longer than 10000 hours[2]. It has also been reported that the surface and interface morphologies have great influence on OLEDs performance[3-4]. We investigated the changes of NPB morphology deposited at different substrate temperatures and its effects on the performance of OLEDs.

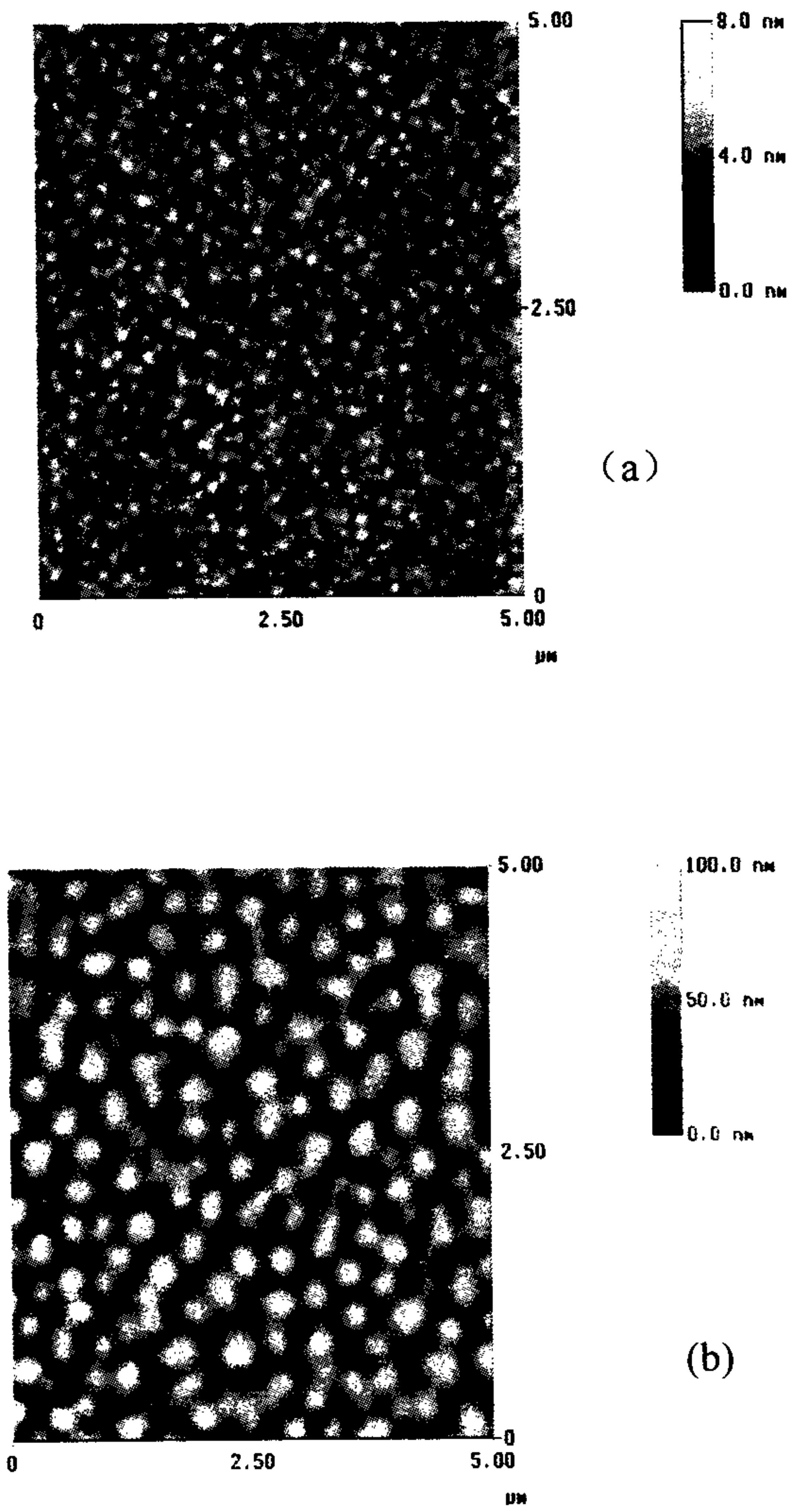
2. Experimental

The substrates used in the experiments were 120±20nm thick ITO-coated glass wafers with a sheet resistance of about 30Ω/□. The samples were pre-treated. NPB films were deposited onto ITO thin film by thermal evaporation at different substrate temperatures which were controlled by a thermoelectric couple. And the Alq3 films and Al electrodes were then sequentially deposited onto NPB in the same way. The whole device structure is Glass/ITO/NPB(HTL)/Alq_3(EML)/Al. The film thickness Alq_3 and NPB were 60 and 50 nm, respectively, and it was measured by a FTM-Ⅲquartz-crystal thickness monitor during deposition process. NPB morphology was measured by Nanoscope IIIa atomic force microscopy(AFM) in tapping mode.

3.Results and discussion

The severe changes of the ITO morphology were not observed in our temperature range[5]. The change of NPB morphology would be affected mainly by the thermal treatment, not by the ITO morphology. The NPB morphologies at different disposition temperatures were shown in Fig.1.AFM topographies show NPB film is grain surface morphology and its surface is smooth and compact when the substrate is at room temperature, while NPB film is insular surface morphology and its surface is rough when the substrate temperature is 100 ℃. By calculating statistically the scanned data with AFM software, the results show an average roughness R_{rms} of NPB film increases from 0.591nm to 10.902nm, while R_{pv} increases from 6.298nm to 77.009nm when the substrate temperature turns from room temperature to 100℃. This indicates that the wetting between NPB and ITO becomes worse when the substrate temperature increases.

In order to explain the relationship between the NPB surface morphology and OLEDs performance, the I–V, B-V characteristics of devices fabricated at different conditions were also investigated. The comparison of current and luminance of two kinds of devices as a function of voltage are shown in Fig.2 and Fig.3, respectively. The only difference is the growth condition of NPB in the whole fabrication of the two kinds of devices. For convenience, the device with NPB film deposited at high substrate temperature (100℃) is called device I in this paper, while the other called device II. The results show the performance of devices is very correlated with NPB morphology. The EL efficiency η_L of devices was compared.



Figs.1. AFM images of NPB film when ITO-coated glass substrate temperature. (a) room temperature and (b) 100℃

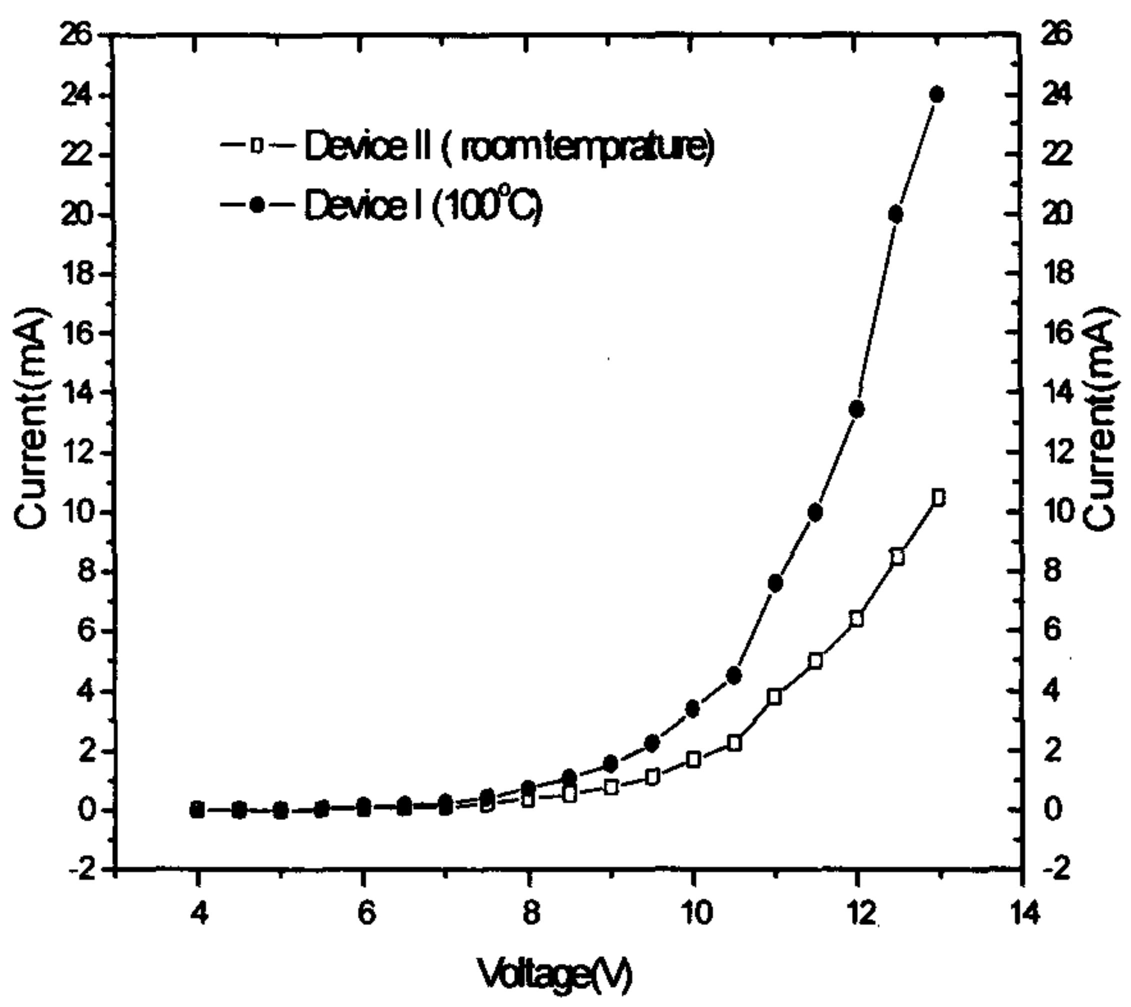


Fig. 2. The comparison of the current as a function of voltage for device I and device II.

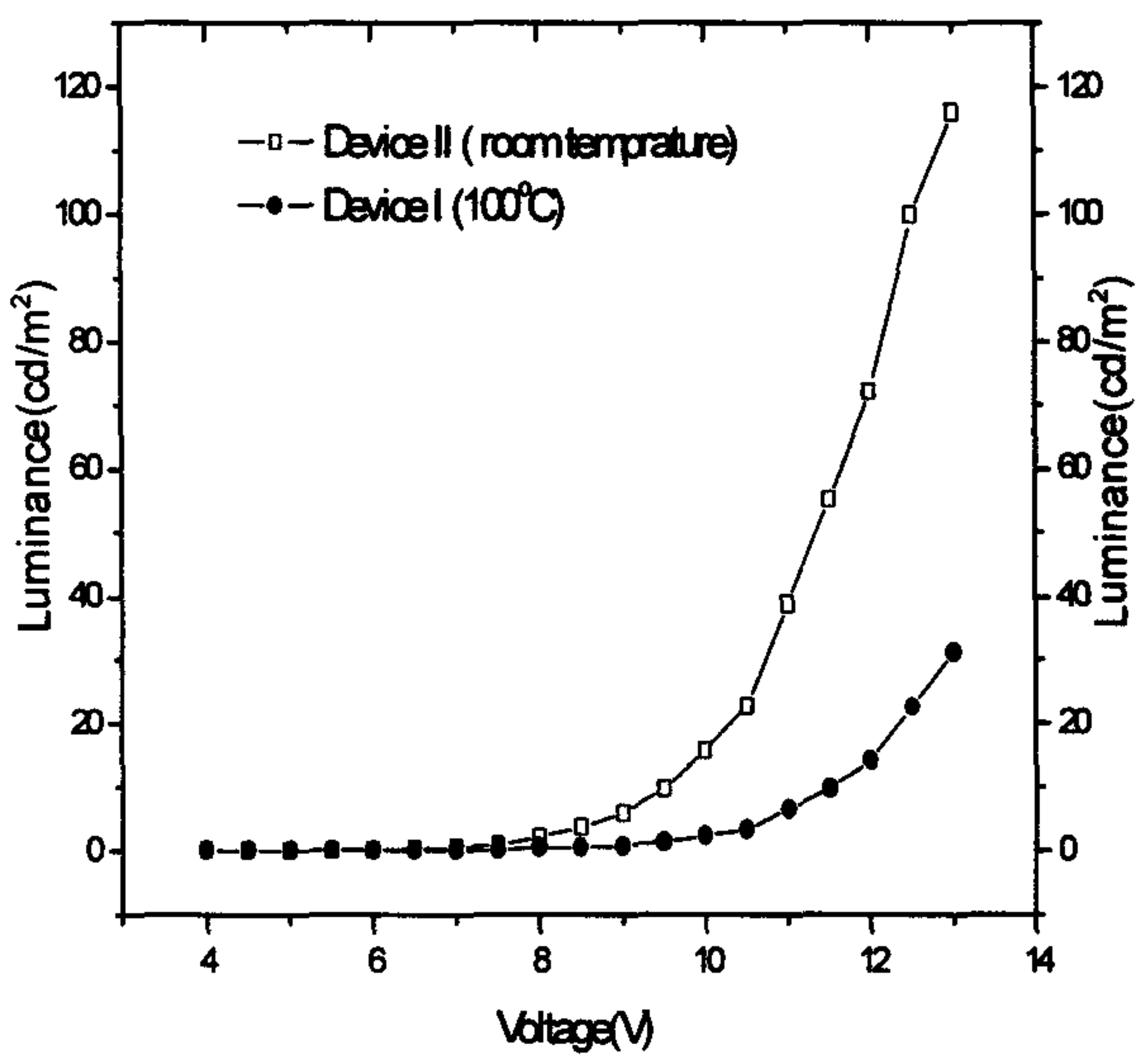


Fig. 3 The comparison of the luminance as a function of voltage for device I and device II.

4. Acknowledgments

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5.References

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