Apparatus and Method of Visual Lifetime Measurement of Organic Light Emitting Devices

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Abstract

The coating and estimation of gas and moisture barriers on polymer and glass substrates are receiving very much attention in passivation of organic light emitting devices (OLEDs). In this study, the encapsulation and lifetime measurement techniques of OLEDs were presented. The degradation mechanisms of bare and encapsulated OLEDs were investigated by the visual lifetime measurement (VLM) system with the parameters such as a pixel luminance(L), a luminance rms roughness(dL), a brightness area ratio(R), an edge degradation depth(D), etc.

1. Introduction

In recent years, organic devices such as transistors and electroluminescence (EL) devices have attracted considerable attention due to their potentials about flexible electronics.[1-4] In particular, the characteristics of flexible organic light-emitting devices (OLEDs) have made such devices feasible for applications requiring large-area coverage, mechanical flexibility, and low overall cost.[5,6] However, Tang and VanSlyke reported that an OLED using well-known EL materials such as tris-(8-hydroxyquinoline)aluminum) (Alq3) has shown a decrease of 50 % its initial intensity in 100 h.[2] Operating OLEDs in air resulted in a 99% loss of EL intensity in as little as 150 min in earlier works by Hamada *et al.*[7] Such short device lifetimes were a difficult problem facing the OLEDs. Therefore, it is necessary to protect the OLEDs from moisture and oxygen by using a passivation layer.

This paper reports on a very thin encapsulation method for OLEDs by using vacuum equipments such as a chemical vapor deposition (CVD). Nitride and oxide films as protecting layers were deposited on polyethersulfone (PES) and glass substrates to estimate the characteristics of the permeability of H_2O and the longevity of OLEDs. The degradation mechanisms of bare and encapsulated OLEDs were investigated by a visual lifetime measurement (VLM) system with the parameters such as a pixel luminance(L), a luminance roughness(dL), a brightness ratio(R), a degradation depth(D), etc.

2. Results

Figure 1 shows the decay curve of normalized luminance for a bare OLED prepared on glass substrate. However, the values of a luminance roughness(dL), a brightness ratio(R), and a degradation depth(D) increased as the rise of time. The rate of nucleation of dark spots was fitted by Avrami's equation.[8] The parameter of Avrami's dimension obtained was approximately 2.04.

Figures 2(a) and (b) show the contour images of optical micrograph for initial sand damaged OLEDs, respectively. The measuring times are 0 and 70 h. The bias current density was 0.05 A/cm^2. When the biased time increased, the processes of nucleation and growth of dark spots were observed and the degradation phenomena of bare OLEDs were very different from encapsulated samples.

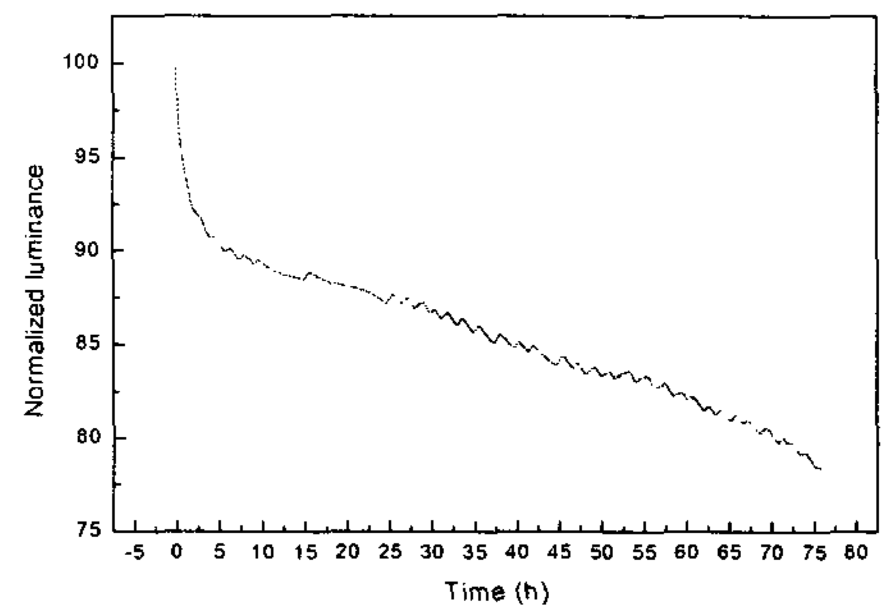

Fig. 1. Decay curve of normalized luminance for a bare OLED.

(a)

(b)

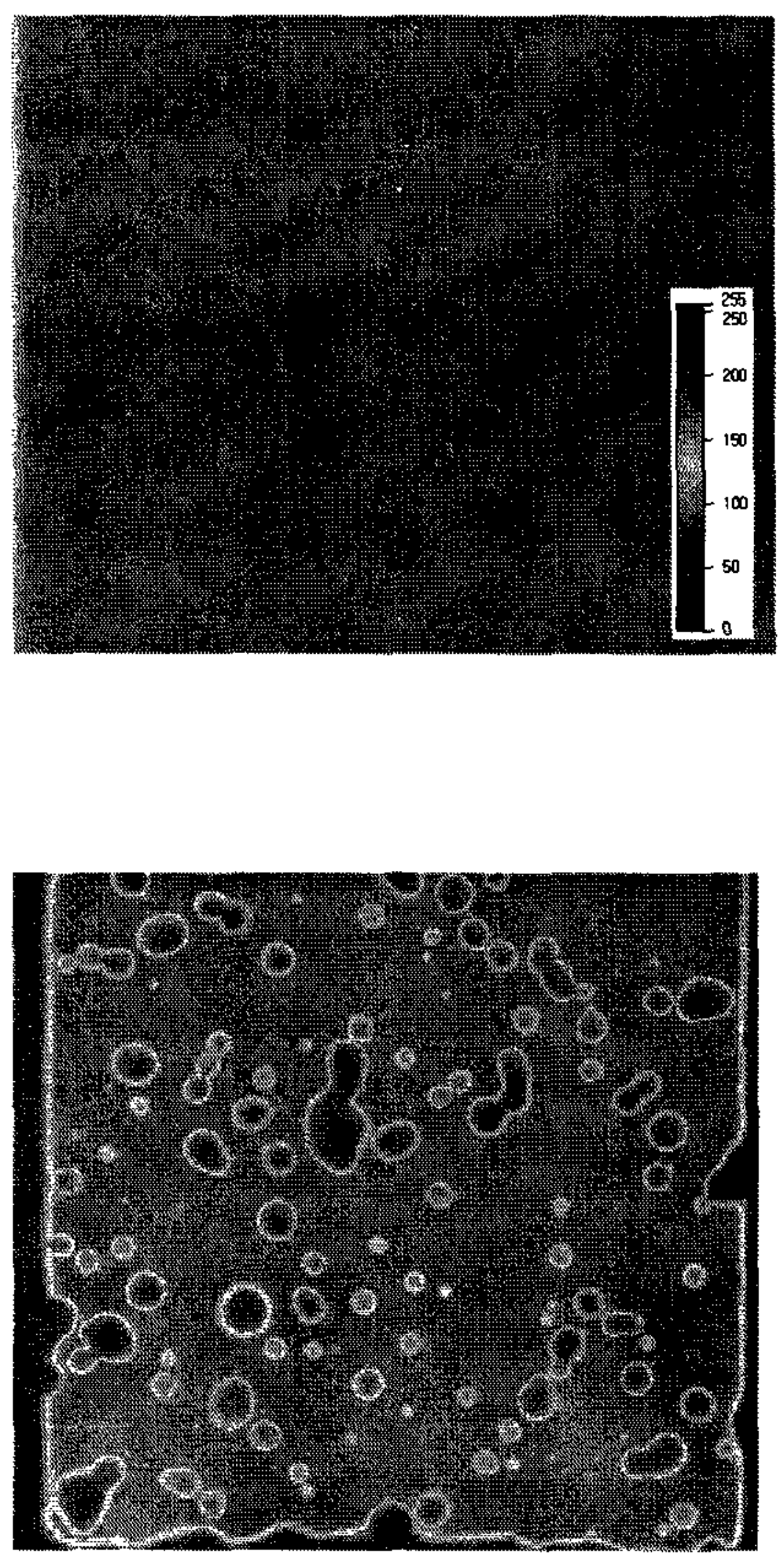

Fig. 2. Contour images of optical micrograph for (a) initial sand (b) damaged OLEDs. The measuring times are 0 and 70 h, respectively.

3. Summary

In this paper, we have investigated the fabrication of the encapsulated OLEDs and the results of reliability observed by the visual lifetime measurement (VLM) system. We discussed the simple phenomenological models to describe the nucleation and growth mechanisms of dark spots in OLEDs.

4. Acknowledgements

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5. References

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