Enhanced Lifetime and Efficiency of Organic Light Emitting Diodes

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Abstract

In this paper, device performances of organic light-emitting diodes (OLEDs) will be presented for AM-OLED and general illumination applications. Various types of advanced devices were developed to enhance the power efficacy and luminous efficiency. Here we also demonstrated longer lifetime AM-OLED structures, which lifetime is about 100 hours until L/L_0 reaches 0.99.

1. Introduction

In recent years, there has been burgeoning interest in the science and technology of OLEDs due to their potential applications in flat panel displays[1,2,3,4] and general lighting[5,6,7]. OLEDs possess several advantages such as low driving voltage, high color purity, wide viewing angle, flexibility, high contrast, and short response time. Thus, they can be a good candidate as a promising general illumination and next-generation flat panel display application. However, due to their lower power efficiency and shorter lifetime, OLEDs should solve critical issues technologically and scientifically to overcome and compete with conventional flat panel displays (LCDs and PDPs) and general lighting (incandescent and fluorescent bulb) in performance and cost. Therefore, several efforts have been made in order to achieve longer lifetime at high brightness, to reduce the power consumption, to enhance luminous efficiency, and to obtain high illumination quality light.

In this report, we described excellent device performance of AM-OLED with high efficiency and long lifetime. These devices were achieved by the unique design of both hole transport layers (HTLs) and electron transport layers (ETLs), which are based on the enhancement of carrier injection and the control of charge balance between electrons and holes. Moreover, we also show highly efficient white OLEDs which are operating at low voltages. These white OLEDs were fabricated by various approaches such as color conversion medium structure, p-i-n structure, fluorescent devices, tandem structures, and phosphorescent devices and so on.

2. Results and Discussions

For the commercialization of AM-OLED in the flat panel display market, it has been a key issue that the initial luminance drop in OLED panels should be suppressed significantly to retard the image burning phenomenon. From this point of view, the device lifetime of OLED can be defined as a point at which the luminance decays to 99% or 98% of the value at t=0 for the practical use. We have developed an advanced device with the use of co-evaporation method, which was controlled by the thickness and composition of co-evaporated electron transport layers and hole transport layers. Research will be presented on the further analysis of degradation mechanism and the details of device structure. The result of electroluminescence degradation curves for the advanced device and reference device are plotted in Figure 1. These curves were obtained from AM-OLED panels which have adopted our advanced device at the brightness of 200 cd/m^2. The advanced device exhibited a higher relative luminance than the reference device after 20 hours of operational time, and a lower rate of degradation was observed as well. The lifetime was prolonged to about 100 hours in our advanced device until L/L_0 reached 0.99. This result might be attributed to the improvement of interface stability between layers and unique material properties developed in this study.

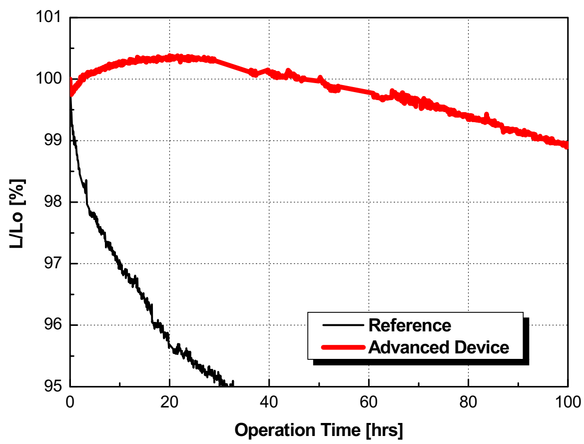

Figure 1. Electroluminescence degradation curves for the advanced device and reference device.

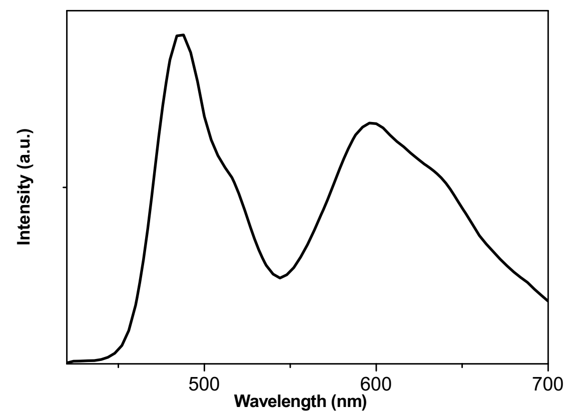

Figure 2. Typical EL spectrum of white OLED.

It is also noteworthy that our advanced AM-OLED devices showed higher luminous efficiencies than those of previous AM-OLED devices. These values were estimated to be 19.5 cd/A, 25.6 cd/A and 7.5 cd/A for red, green and blue, respectively. This results were obtained at the brightness of 200 cd/m^2 in full white from 2.0-inch diagonal full color AM-OLED (QCIF+) driven by low temperature polycrystalline silicon (LTPS) based on thin film transistors (TFTs).

Figure 2 shows the typical EL spectrum of fluorescent white OLED, which was developed in this study. This device has been demonstrated to have the power efficacy of about 10 lm/W at the brightness of 1000 cd/m^2. The values of chromaticity coordinates and luminous efficiency were largely dependent on the thickness and composition of interlayer between two emitting layers, thickness of emitting layers, and doping concentration. The power efficacy was also improved significantly with the lamination technique by array of microlens, which leads to approximately 50% enhancement of out-coupling. The arrays of lens were optimized by the aspect ratio of lens, diameter of lens, and fill factor of lens.

3. Conclusions

Various types of organic light emitting diode devices were developed to enhance the lifetime and power efficiency for flat panel display and general lighting application. It was demonstrated that this device had a high effectiveness to prevent the degradation of OLEDs. These unique devices developed in the present study will provide further opportunities for numerous potential OLED applications.

4. References

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