Highly efficient and stable polymer light emitting display

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Abstract

Rapid progress has been achieved towards commercially viable full color polymer OLED devices. New full color polymer OLED displays which incorporate a novel hole injecting-transporting layer show high efficiency, low operating voltage and long lifetimes. The performance of a 14.1" WXGA a-Si based solution processed AMOLED full color display is described.

1. Introduction

The technology for flat panel OLED displays has been accelerating rapidly as interest in application for large OLED TVs. The early promise shown by light emitting polymer (LEP) technology is now being realized with a number of products on the market. Clearly, the LEP systems offer a unique benefit by virtue of their inherent solution processability which allow simple printing techniques to be used (instead of requiring complex and costly tools for the alignment of delicate shadow masks in a high vacuum OLED deposition chamber). Consequently, relatively cheap, high quality displays can be fabricated. However, for full color polymer OLED display the RGB performances are still somewhat limited by currently available hole injection and transport materials. Also, their processing does not yet provide the ideal solution for use in OLEDs, especially polymer-based OLEDs. This warrants more detailed understanding of full color device characteristics and their degradation mechanism.

2. Results

We have recently made significant improvements in the efficiency and operational lifetimes of polymer OLED displays through fundamental understanding and control of the degradation mechanism which previously limited device performance. This breakthrough has led to efficiency 2-3x higher and operating lifetimes 4-10x longer than previously attainable, simultaneous with other properties which will be beneficial to the operation of displays, such as a reduced voltage increase rate, and reduced likelihood of corrosion. This breakthrough has come through a much better understanding of the interactions between the various polymer layers in a PLED display. Detailed studies, using a variety of analytical tools to probe the nature of the polymer films, and the interfaces between them gave clues as to the mechanism of device degradation and supported the next step towards fixing the problem or designing better materials and device structures. We were able to mitigate these problems in a simple way which gave an immediate and dramatic performance improvement. This solution will be readily implemented into the existing PLED manufacturing lines.

2.1 Hole Injecting-Transporting Materials

A recent development progress is the discovery of a unique hole injecting-transporting material to solve the most significant degradation problem of polymer light emitting diodes (PLEDs).[1] Using this proprietary DuPont hole-injector gives considerably higher performance than with the more commonly used, PEDOT:PSSA hole injector. The DuPont hole-injector offers other significant attractions: higher work-function, better hole injection property, lower voltage increase rate, lower barrier height increase rate to hole injection, less acidic pH, exceptional stability and etc.

2.2 RGB Device Performances

Improving the efficiency and stability of LEP devices is crucial for the commercial exploitation of LEP technology in flat panel display applications. The results presented in Fig. 1 show a dramatic increase in device performance in the last couple of years which was achieved through continuous development of new, more stable materials together with systematic

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improvement in the device fabrication process, a new device architecture and understanding degradation mechanism.

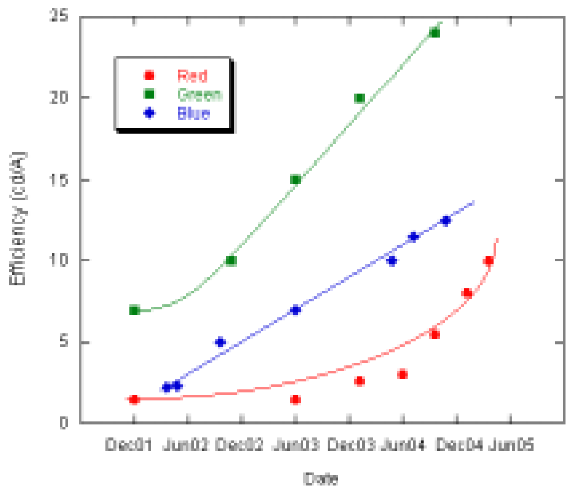

Figure 1. Improvement in efficiency of RGB devices

2.3 FC AM Display Properties

We, in collaboration with Samsung Electronics, have developed a 14.1" WXGA a-Si TFT based solution processed AMOLED full color display as shown in Fig 2.[2] By combining a-Si TFT and solution processed OLED architecture, outstanding display performance has been realized. This display contains over 3 million sub-pixels.

Figure 2. 14.1" WXGA a-Si based solution processed AMOLED full color display

Table 1 shows detailed performance data in an active matrix display. The current efficiencies of 3.5 cd/A for red, 15 cd/A for green, and 8 cd/A for blue, while maintaining over 60% color gamut was attained by implementing the DuPont hole injection layer described earlier. By optimizing display architecture and process, high power efficiencies of 5 lm/W were achieved. This is equivalent to less than 50% of the power that is required by a comparable LCD display (compared at equivalent luminance and size).

Table 1. Display performance of 14.1" solution processed AMOLED

Display Size	14.1 inch		
Resolution	WXGA (1280 x 768)		
Pixel density	106 ppi		
Color points & efficiency	R	0.66, 0.33	3.5 cd/A
	G	0.38, 0.62	15 cd/A
	B	0.15, 0.17	8 cd/A
Peak Brightness	500 cd/m^2		
Power efficiency	5 lm/W		
Contrast ratio	2000:1		

3. Conclusion

DuPont has brought the full color solution processed OLED technology to an industrial level by developing unique hole injecting layer. This has allowed us to fabricate high performance full color AMOLED displays with power requirements that are substantially lower than equivalent LCD displays. We continue to study the root-causes of the degradation mechanisms in AMOLED displays in order to further refine our proprietary technology in solution processed OLED, which will lead to even higher efficiency and longer lifetime.

4. Acknowledgements

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5. References

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