

Full Color Polymer OLED Display Driven by a-Si:H TFT Utilizing a New Current-Programmed Method

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ABSTRACT

A 2.1-inch, full color polymer OLED display is demonstrated, which uses a new current-programmed method driven by a-Si:H TFTs. From the mass production point of view, a-Si:H TFT is almost perfect and polymer OLED is attractive. They are also excellent technology for large sized displays. The wide compensation capability and good linearity for gray scale are shown by 3-TFT and 3-busline pixel circuit.

INTRODUCTION

TV monitor application is a good use for OLED display rather than mobile application because of its high response, wide viewing angle and high contrast in dark comparing with LCD. Therefore the panel for this application is required to be driven by an active-matrix (AM) method and to have a larger panel-size. In this point of view amorphous silicon (a-Si) TFT technology is more suitable than low-temperature poly-silicon (LTPS) technology for the present to achieve a low cost and large size product even though the latter technology is getting improved.

The technology of a-Si TFT has a good uniformity in the threshold voltage and the mobility even in large size panel but it has a big bias-temperature-stress (BTS) shift in threshold voltage, which results in a sticking image and a short display lifetime. There is more than 40 % degradation in driving current or OLED brightness after BTS of 10,000 seconds [1]. Therefore AM-OLED using a-Si TFT must also have the compensation circuit in the pixel as well as AM-OLED using LTPS TFT.

There are two ways to compensate the TFT threshold voltage variation, current-program [2] and voltage-program [3]. Both of them needed more than four TFTs and four bus-lines for each pixel in general, which is too complicated in driving scheme and too busy

in pixel area to achieve the high reliability and large aperture ratio. Simpler circuit design and driving scheme are expected in a-Si TFT driving AM-OLED. In SID'03 three TFT voltage-program pixel circuit was presented using in 20 inch a-Si TFT AM-OLED [4]. This driving technology makes possible to drive large-sized AM-OLED utilizing a-Si TFT.

We demonstrated a 2.1-inch, full color polymer OLED display, driven by a-Si TFTs utilizing new current-program method, which needs only three TFTs and three bus-lines for each pixel. The simple structure retains the aperture ration and reduces an unnecessary voltage loss. These tautologies, three a-Si TFT current program method and polymer OLED technique, are very promising to achieve the TV monitor application for OLED display.

Pixel Circuit And A Set Of Timing

Figures 1 and 2 show a pixel driver circuit and a timing diagram of the signals, respectively. At the beginning of the select period, the data line is grounded by V_{reset} to discharge the data line and the OLED anode. Then I_{data} is set to the pixel circuit with a sink mode. To prevent the current flow through the OLED, V_{source} is also grounded and the OLED is biased reversely. Therefore I_{data} corresponds to I_{T3} and C_s stores the voltage to keep the I_{T3} . During hold period, V_{source} is set to be V_{cc} and I_{T3} keeps flowing according to the voltage on C_s .

OELD Fabrication

Ink jet printer was used for coating EL materials. PEDOT/PSS ink was applied into pixels on the TFT substrate as hole injection layer. Then polyfluorene ink was applied into the pixels as emitting layer on the PEDOT/PSS layer. After inkjet process substrate was heated at 120°C.

RESULT

The specification of the 2.1-inch OLED display are indicated in Table 1. Fig.5 shows an example of displayed image. Fig.4 shows Luminance versus Gray-scale characteristic. Because our operation current is very small (ex. 20nA~5uA) we are afraid of the writing insufficiency which is caused by the parasitic capacity at lower gray scale. But it had not been observed.

CONCLUSIONS

We have succeeded in development of the 2.1-inch polymer OLED display using novel and simple pixel driver circuit by a-Si:H TFT. The Display has not only excellent feature as OLED but also good productivity.

ACKNOWLEDGEMENTS

We would like to thank Mr. A. Mawatari for their encouragement during the course of this work.

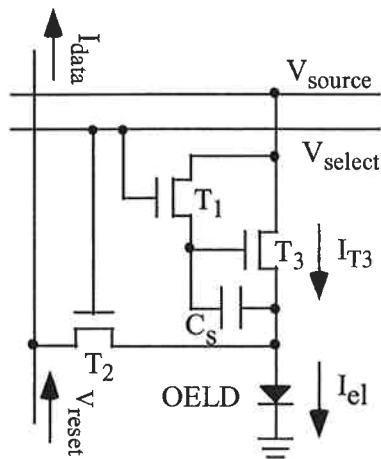


Fig.1 3 Tr pixel driver circuit

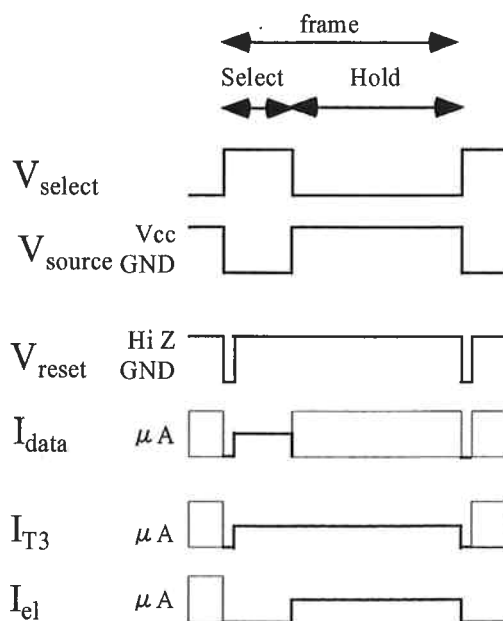


Fig.2 Timing diagram

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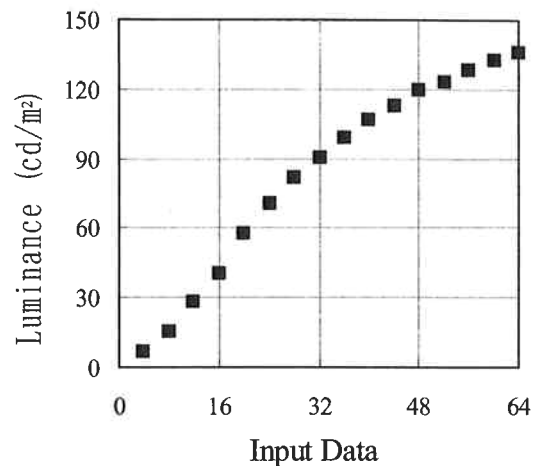


Fig.4 Luminance versus Gray-scale characteristic



Fig.5 Display image of the OLED

Table 1 Specifications

Items	Specification	
Size (Diagonal)	5.2 (2.1)	cm (inch)
Dot format	160(H)×RGB×128(V)	dot
Dot pitch	0.252(H)×0.252(V)	mm
Frame frequency	30	Hz
Color arrangement	RGB-stripe	
Input signal	RGB each 6-bit	
CIE Color Coordinate	R (0.69, 0.31)	
	G (0.40, 0.58)	
	B (0.15, 0.15)	
Contrast Ratio	> 100 : 1	