A Micro OLED Pixel Driving Scheme To Ensure The Uniformity Of Low Gray Scale

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ABSTRACT

This paper proposes a Micro OLED pixel driving scheme, which can ensure that the pixel uniformity can reach more than 95% under the low gray scale 2nit brightness, and to a large extent meet high-end customers' demand for high picture quality experience.

1 Introduction

Silicon-based OLED micro-display is a combination of CMOS process and OLED technology, using silicon-based wafer as the substrate, and has the characteristics of self-luminescence, etc[1]. And can be divided into passive driving OLED (PMOLED) and active driving OLED (AMOLED) according to different driving methods. Silicon-based OLED is small in size, light in weight, low in power consumption, and high in PPI. It is the core device of the near-eye display system and the trend of the next generation of micro-display technology[2].

As consumers' demand for image information density gradually increases, and the actual application scenarios of integrated Micro OLED displays, in addition to the requirements for traditional display core parameters, customers have higher and higher requirements for the uniformity of low grayscale pixels. The uniformity of low-gray-level pixels is related to many factors, such as the manufacturing process of the silicon-based backplane, the design of the Micro OLED pixel, and the subsequent process conditions.

This paper proposes a Micro OLED pixel driving scheme, which can not only meet the above key indicators, but also ensure that the uniformity of pixels can reach more than 95% at low grayscale 2nit brightness. To a large extent, it meets the needs of high-end customers for high-quality experience.

2 Technical solution discussion

Silicon-based OLED fabricating logic drive part on IC wafer, including pixel drive and GOA, as well as the previous IC drive part (all integrated on the wafer), as the traditional display area and the drive function unit are integrated, eventually form a system integration plan. Figure 1 is a structure diagram of a silicon-based OLED display device. After the wafer is made, the anode and subsequent EL parts are formed, and the CF and cover are finally process[3].

The principle of pixel driving is explained in detail below. Fig 2 shows the voltage-type pixel driving circuit.

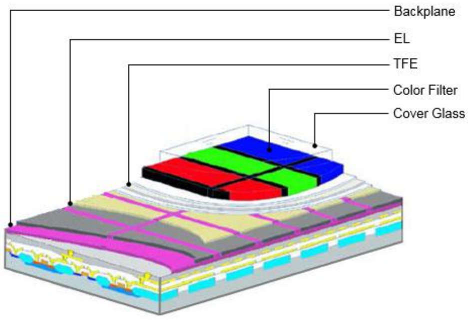

Fig.1 Micro OLED structure

In the pixel circuit, N1, N2, and DTFT are N-type MOS, P1, P2, and P3 are P-type MOS, and there are storage capacitors C1, Gate1, Gate2, EM, and Discharge as switching signal lines, the grid of P3 is connected to a fixed potential(GND).

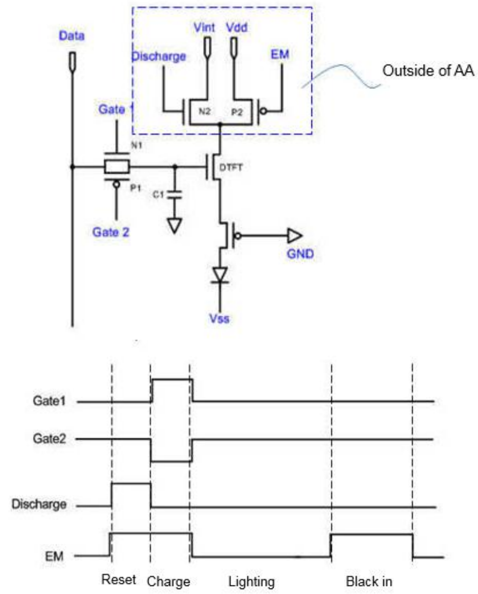

Fig.2 Pixel circuit and Timing

The specific working process of pixel drive is described in detail below. Fig 3-1. Reset phase, when

Discharge is pulled high, N2 is turned on, P1, P2 and N1 are disconnected. This process resets the anode b of the anode to V_{int}, and resets the voltage signal of the anode of the previous frame.

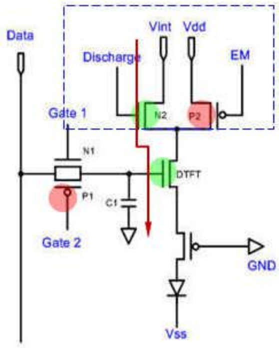

Fig.3-1 Reset phase

Fig 3-1. Reset phase, when Discharge is pulled high, N2 is turned on, P1, P2 and N1 are disconnected. This process resets the anode b of the anode to V_{int}, and resets the voltage signal of the anode of the previous frame.

Fig 3-2. Charging stage, at this time P1, P2, N1 are turned on, N2 is turned off, V_{data} charges the gate of DTFT(Driving NMOS) through capacitor C1, and a section of C1 capacitor is charged to V_{data}. The reason why this solution chooses N1 and P1 is reverse the device, mainly can increase the driving voltage range of Data, NMOS corresponds to high voltage V_{data}, and PMOS corresponds to low voltage V_{data}.

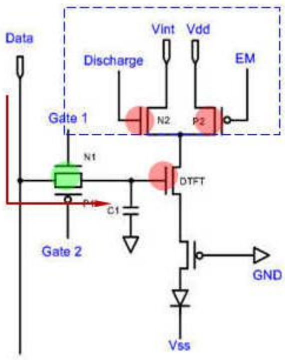

Fig.3-2 Charging stage

Fig 3-3. Light-emitting stage, the pixel is officially light-emitting stage. At this time, P2 is turned on. According to the principle of source follower, point a is V_{data}, and the potential of point b is kept close to V_{data} -V_{th}. At this time, the potential of the source of the light-emitting stage is connected to V_{dd} , The current through P2→DTFT makes the OLED start to emit lighting.

Fig 3-4. PWM black insertion process, the black insertion method in the display process uses EM duty to control the light-emitting time, thereby achieving brightness control.

3 Test results

It can be seen that with this pixel drive scheme, the uniformity of the product under low grayscale brightness can reach more than 95%. This result is based on the

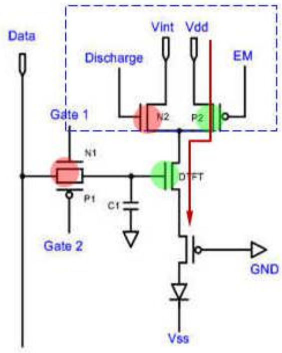

Fig.3-3 Light-emitting stage

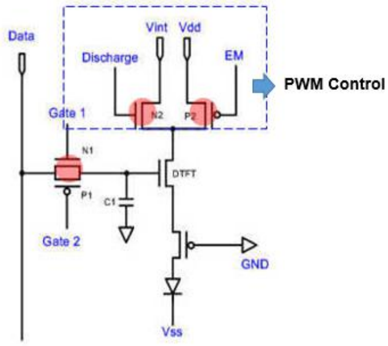

Fig.3-4 PWM Process

normal distribution algorithm. In the demura evaluation process, the most critical part is how to quantify the uniformity of sample pixel brightness[4].

The pixels of display products generally exhibit a normal distribution of brightness under the common influence of the process and the pixel drive circuit, so the standard deviation becomes an important indicator of uniformity. The demura test calculation formula is as follows:

$$\text{Uniformity}=1-(3*\text{Sigma})/(\text{Ave.})$$

$$\text{Sigma}=\sqrt{\frac{1}{N}\sum_{i=1}^{N}(L_i\text{ -Ave.})^2}$$

L_i stands for pixel-level brightness value, and Ave Represents the average of the brightness value of all pixels.

Fig 4 shows the pixel uniformity results of actual shooting, and Fig 5 shows the calculation results of normal analysis.

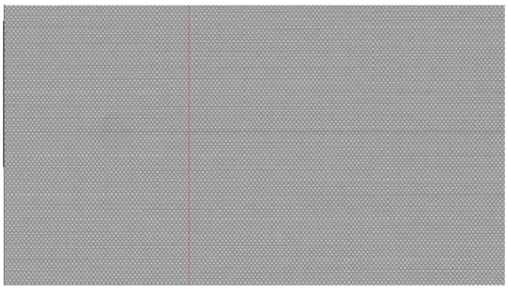

Fig.4 Pixel demura photo picture

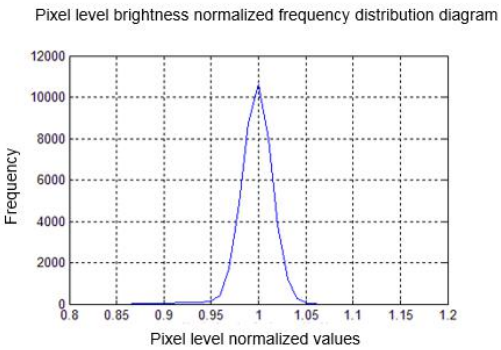

Fig.5 Demura normal distribution result

4 Conclusion

The voltage-type silicon-based OLED pixel drive circuit design proposed in this paper guarantees high PPI and pixel output uniformity under certain medium-voltage MOS process constraints (this patent uses Foundry Process 0.11um, 6V process). Uniformity reaches more than 95% under low brightness, ensuring customers' demand for low grayscale display images.

References

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