A High Aperture Ratio TFT Design for Bottom Emission Type AMOLED

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ABSTRACT

A new design for improving the aperture ratio of bottom emission type AMOLED is investigated. In conventional, the TFT of AMOLED fabrication method is "Etch Stopper (7-mask)", so the aperture ratio is limited in 28~33% by Cs(Storage Capacitor). A high aperture ratio TFT is designed by using BCE(Back Channel Etching 5-mask) fabrication way and the aperture ratio is up to 40% shown in 2.2"AMOLED display.

Keywords: BCE(Back Channel Etching), Etch Stopper, Cs(Storage Capacitor)

INTRODUCTION

In the a-Si TFT design of Bottom Emission model of AMOLED, it is important to design a sufficient storage capacitor (Cs). In order to create a large Cs, we have to design a large metal area to be Cs generally. For the reason mentioned above, the aperture ratio of TFT array pixel will be limited to 28~33%. In other words, it needs trade-off between Cs and aperture ratio when we design our array pixel. A new design for improving the aperture ratio of bottom emission type AMOLED is investigated in the paper. The TFT design uses the fabrication advantage of BCE (Back Channel Etching 5-mask) to create sufficient Cs, and doesn't increase the area of Cs. At the same time, the aperture ratio can be up to 40% shown in 2.2"AMOLED display.[1][2]

FABRICIATION

The comparison of the fabrication methods between BCE and Etch stopper in different metal layers' connection are shown as Figure 1, 2.

Etch Stopper method: we can connect different metal layers by CH (contact hole) directly.

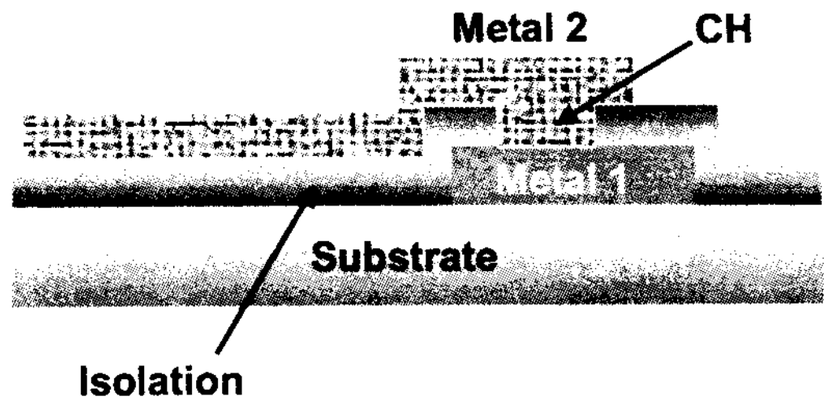


Fig. 1 The different metal layers connection method in Etch Stopper fabrication.

BCE method: In order to decrease the number of masks, we have to use ITO to connect different

metal layers.

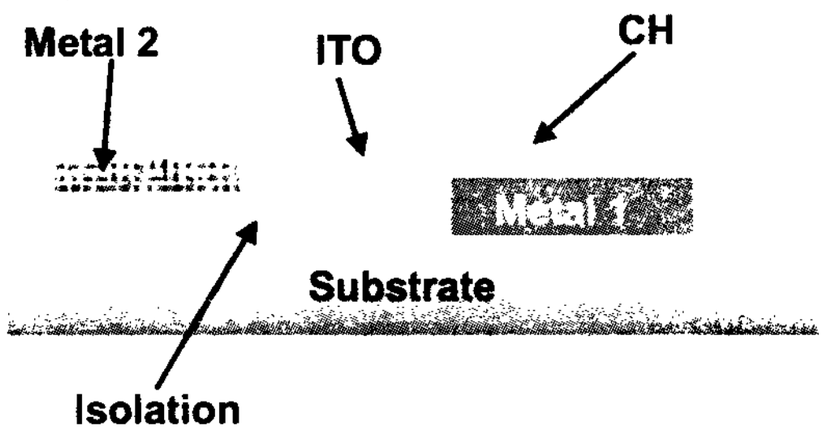


Fig. 2 The different metal layers connection method in BCE fabrication.

DESIGN SPECIFICATION & MODEL

1.Specification

Table 1

	The spec. of Design
Display	2.2" AMOLED
Type	Bottom Emission
Resolution	176x3(RGB)x220
Pixel size(H)	66 um
Pixel size(V)	198 um
T1 W/L	10/3
T2 W/L	140/3
Metal1	Cr
Metal2	Cr
Vd width	7
Vdd width	12
Cs	0.4pf
Aperture Ratio	28%~35% < 40%

2.Equivalent Circuit Model

We use 2T1C(2 TFT & 1 Storage Capacitor) model to drive a pixel. The relationship between T1 and T2 is as following formula. [1][3][4][9][10]

$$V_{G2}(T2) = Vd(T1) \quad (1)$$

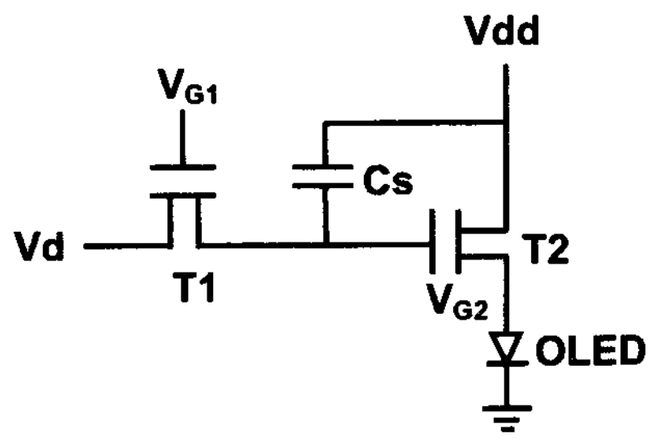


Fig.3 AMOLED Equivalent Circuit Model

3. Cs in Etch Stopper Type

In conventional, the AMOLED is fabricated by Etch Stopper type. The M2 of T1 can connect to the M1 of T2 directly by contact hole. And then, the M1 and M2 of T2 are separated by SiNx to be Cs. So the overlapping area of M1 and M2 decides the Cs. It is shown in Fig.4.[7][8]

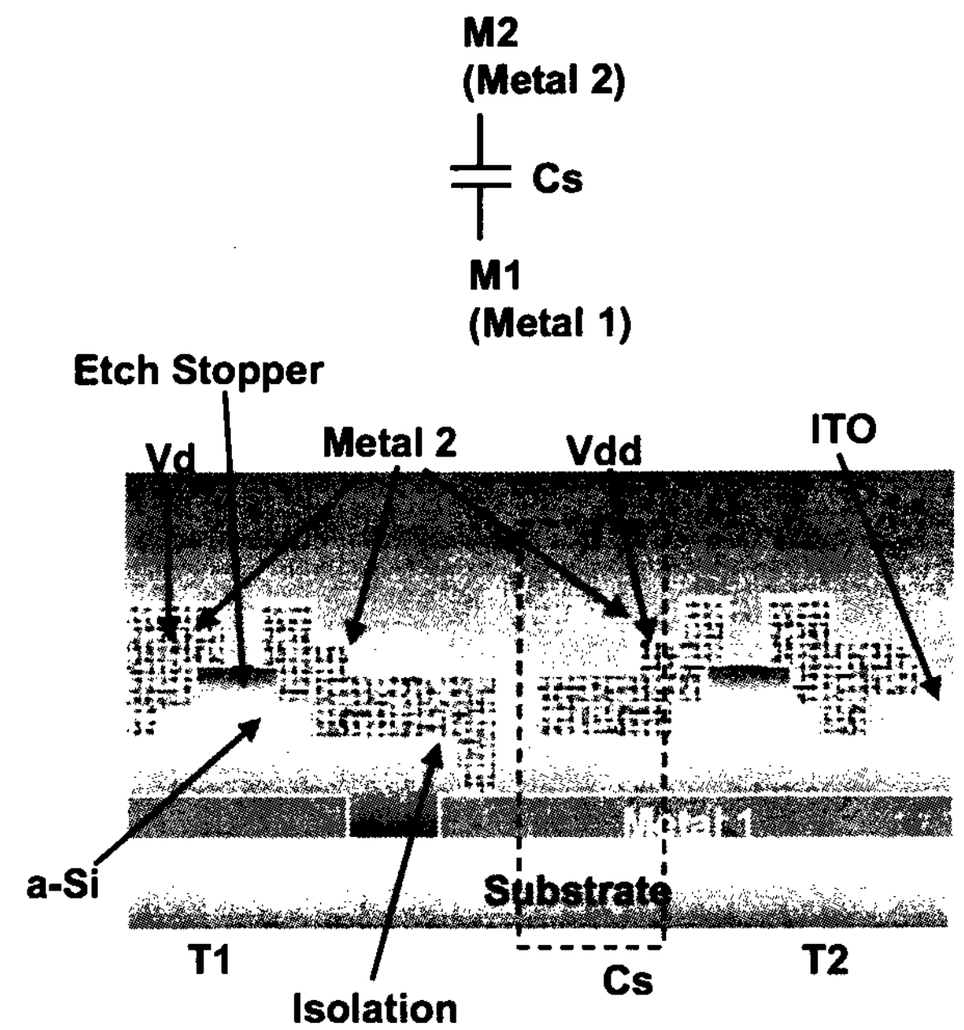


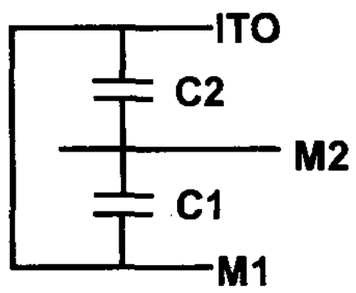
Fig.4 Cs in Etch Stopper Type

4. Cs in BCE Type

The design concept is shown in Fig.5[5][6]. We use ITO layer to connect the M2 of T1 with the M1of T2 by contact hole. The ITO and M2 of T2 become C1. The M1 and M2 of T2 also become C2. C1 and

C2 are parallel to be Cs, so the Cs will be increased and the area of Cs can be kept in smaller range.

Cs = C1+C2



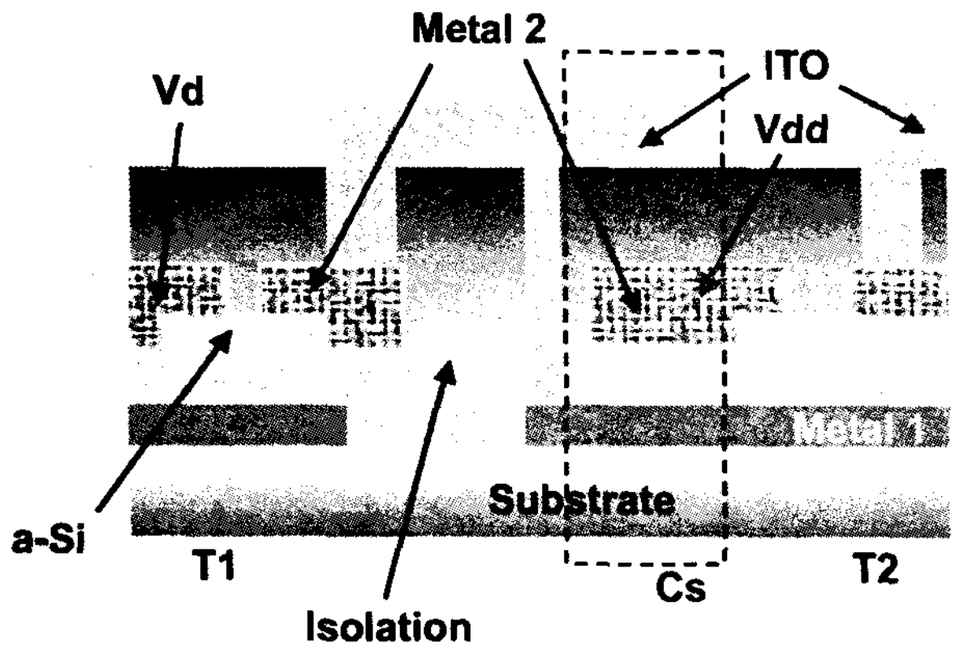


Fig.5 Cs in BCE Type

RESULT

A high aperture ratio of array pixel is obtained. The design is used in 2.2" AMOLED mobile phone product. The result is shown in Table 2.

Table 2

	The Result of Design
Display	2.2" AMOLED
Type	Bottom Emission
Resolution	176x3(RGB)x220
Pixel size(H)	66 um
Pixel size(V)	198 um
T1 W/L	10/3
T2 W/L	160/3
Metal1	Cr
Metal2	Cr
Vd width	7
Vdd width	12
Cs	0.399pf
Aperture Ratio	42%

CONCLUSION

We use the process characteristic of BCE fabrication method to increase the Cs and aperture ratio. The new array pixel design of improving the aperture ratio of bottom emission type AMOLED when the Cs needs to be increased is investigated. We made the aperture ratio of array pixel above 40% and the Cs be kept about 0.4pf. The method is used in the product of 2.2" (176xRGBx220) AMOLED.

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