Development of 2.32-inch 320×350 LTPS TFT-LCD for Advanced Mobile Phones Using SLS Technology

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Abstract
2.32-inch 320×350 TFT-LCD with high resolution (206PPI) for advanced mobile phones could be successfully developed. The compact pixel design based on PMOS SLS technique is used to achieve this high resolution. Gate driver and part of data driver are integrated onto the glass substrate. High brightness (170cd) and contrast ratio (400:1) were obtained with very low flickering and crosstalk levels.

1. Introduction
Recently, as the development of the mobile applications, resolution of the display panel becomes more and more important, especially after the appearance of DMB (Digital Multimedia Broadcast), which can provide the services to watch video clips and listen to radio programs transmitted via satellite to mobile phones. For DMB phones, the resolution of qVGA (240×RGB×320) is the least configuration of the main display panel because the DMB video image is landscape qVGA.

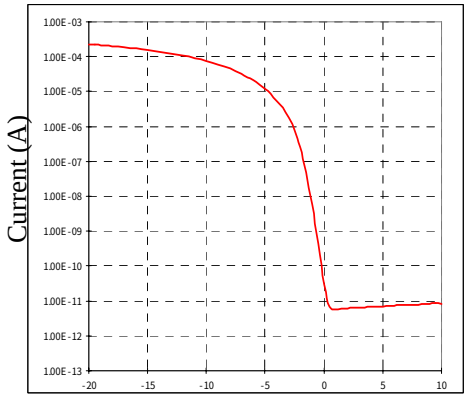
Two mainstream processes in AMLCD for mobile display are a-Si and LTPS (low temperature poly silicon).[1] The mainstream resolution of a-Si product of a-si is under qVGA. The obstacle is that standard a-Si TFT-LCD panel has more than 1000 external connections when the resolution increases to qVGA. While for LTPS TFT-LCD, high mobility of the carriers is the prerequisite of the realization of high performance TFT and integration of driver circuit onto glass substrates. Thus the number of connections can be reduced drastically and resolution of LCD panel can be higher than qVGA.

The essence of LTPS process is the silicon crystallization. For the time being a lot of crystallization techniques have been developed including SLS (Sequential Lateral Solidification), ELA (Excimer Laser Annealing), MILC (Metal Induced Lateral Crystallization), et al. Among these, SLS technique shows the obvious advantages on efficiency, film uniformity and performance.[2,3] In SEC, SLS technique has been the dominant technique in LTPS mass production line.

In this paper, we present a novel 2.32-inch LCD panel with the resolution of CIF+ based on our specific SLS technique. Adoption of compact pixel design and integration of gate and source driver circuits onto panel are the essential to achieve such high resolution (206PPI, pixel per inch).

2. Panel design
The panel for DMB phone is designed based on PMOS SLS process. Figure 1 shows the I-V characteristics of SLS-based PMOS TFT. Small size of pixel TFT can reach relatively high driving ability due to the high on current. Usually the leakage current

of LTPS TFT is higher than a-Si TFT. In this panel, dual gate TFT is designed to restrain the leakage current. The circuit diagram and cross section are shown in Figure 2.



Gate Voltage (V)

Figure 1 I-V characteristics of SLS-based PMOS TFT

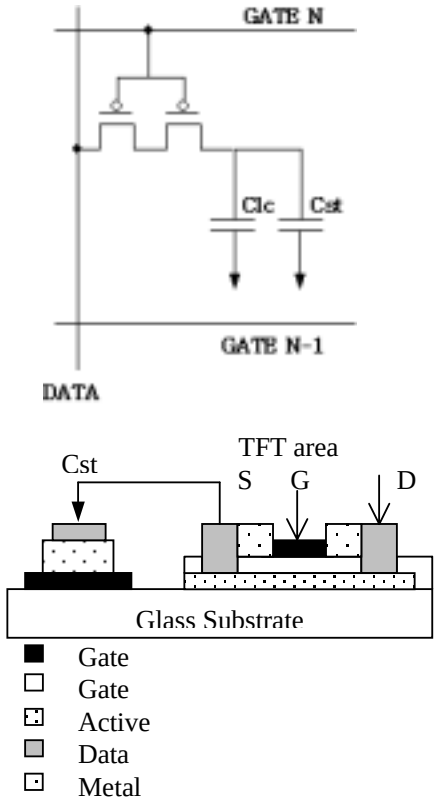


Figure 2 Circuit diagram and cross section of pixel TFT

To reach high resolution, the distance between two pixels is also decreased as much as possible. The design is shown in Figure 3. The pixel parameters are

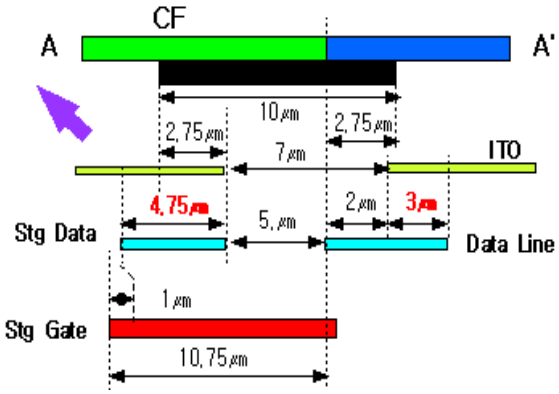


Figure 3 Detail parameters of

Table1 Compact Design of panel parameters

Parameter	2.32-inch panel
Panel size (mm^2)	44.85(H)×52.37(V)
Display area (mm^2)	39.85(H)×43.54(V)
Aperture ratio	41%
Pixel size (μm^2)	41(H)×123(V)
ITO-ITO (μm)	7 (H) 13.5 (V)
Black matrix (μm)	10 (V) 27 (H)
Dead space (mm)	2.5(each side)

Gate driver blocks and parts of the source driver are integrated onto the panel to reduce the number of connections and then increase the panel resolution. All other components to drive TFT-LCD panel such as power circuits, timing controller and level shifter are integrated in a single driver IC (Figure4).

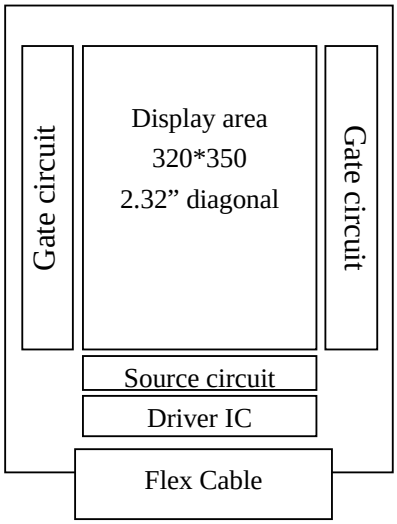


Figure 4 Panel blocks

3. Results

The specifications are listed in Table2. 206PPI is one of the highest panel resolutions to be mass produced.

Table 2 Panel specifications

Parameter	Spec
Diagonal size (inch)	2.32
Number of pixels	320×RGB×350
PPI	206
Optical Mode	Transmissive
Brightness	170 cd
Contrast ratio	400:1
Number of Color	65k/262k
Color Reproducibility	50
Interface	RGB

Figure 5 shows the display quality of this 2.32” LTPS LCD panel. During our test, the panel shows stable characteristics with very low flickering and crosstalk level.

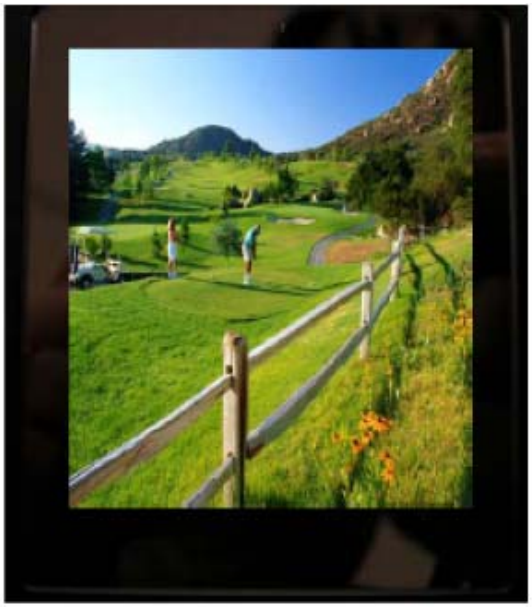


Figure 5 Display photograph

4. Conclusions

This panel was adopted for mass production of DMB application. Test results showed that the overlap due to compact pixel design does not affect the display quality much. And adopting this panel can also reduce DMB phone set’s complexity because it does not need to be rotated when display a qVGA landscape (320×RGB×240) video image.

5. References

[1] J. Jeon, W. K. Lee, J.H. Song, and H. G. Kim, Journal of Information Display, 5, 1 (2004)

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