Development of High Aperture Ratio 2.1" QVGA LTPS (Low Temperature Poly Si) LCD Using SLS (Sequential Lateral Solidification) Technology

Myung-Koo Kang
LTPS Team, Mobile Display Business Team, Samsung Electronics., Nong-seo Ri, Ki-Heung Up, Korea

Joong Sun Lee, Jong Hwa Park, Lintao Zhang, Seung Yong Joo, Chul Ho Kim, il Kon Kim, Sung Ho Kim, Kyung Soon Park, Chun Ki Yoo and Chi Woo Kim[1]
LTPS Team, Mobile Display Business Team, Samsung Electronics., Nong-seo Ri, Ki-Heung Up, Korea

Abstract
High resolution 2.1" QVGA LTPS LCD (190ppi) having high aperture ratio of 65% could be successfully developed using state-of-the-art SLS technology and active/gate storage structure. Cost effective P-MOS 6-Mask structure was used. Full gate and transmission gate circuits are integrated in the panel. The high aperture ratio was obtained by using active/gate capacitance structure, which can reduce storage capacitance area. The aperture ratio was increased to 65% from 49% of conventional gate/data capacitance structure. The brightness was increased from 180cd to 270cd without any degradation of optical properties such as contrast ratio, flicker or crosstalk.

1. Introduction
Polycrystalline-silicon (p-Si) thin-film transistors (TFTs) are used in a variety of applications, including large-area electronics [1,2] and vertically stackable components for three-dimensional integration [3]. Especially, it is used in mobile display area because circuit integration is possible in the panel due to much higher TFT performances than conventional amorphous-silicon (a-Si) materials. Circuit integration can make device size compact and module process cost decrease because it can reduce IC size and can remove COG (Chip on Glass) process.

To achieve satisfactory integration level, higher TFT performance is essential. For getting a high TFT performance, crystallization process of a-Si is the key process. SEC has developed SLS technology which can make large laterally grown Si. Using this laterally grown Si, SEC could fabricate TFTs having higher performance and applied it to various commercial products successfully. [4]

On the other hand, as new technology such as DMB (Digital Multimedia Broadcasting) requires high performances such as high resolution, high brightness and high color gamut additional to circuit integration, Conventional a-Si or LTPS TFT-LCD using gate/data capacitance where thick inter-insulting dielectric film exists shows a limitation in the aperture ratio and isn't suitable for high end application.

In this paper, a high resolution TFT-LCD using active/gate capacitance where thin gate insulator is used was fabricated. With high aperture ratio, excellent optical performance could be obtained..

2. Fabrication Procedure
SLS crystallization technology was used for getting a poly crystalline material. The grain size of SLS TFT is a few micrometers order that is about ten times larger than that of conventional ELA technology. Due to this large grain size, the TFT performance is much higher than that of ELA TFTs.

The TFT fabrication process follows normal LTPS top gate process. A pixel is composed of TFT area and storage capacitor. Conventional structure uses gate/data metal as an electrode and interlayer-dielectric (ILD) film as an insulator. In this case, the thickness of ILD layer is so thick that storage area should be increased for getting a satisfactory storage capacitance. The aperture ratio is decreased and optical performance is degradaded.

To overcome this, p-Si (active)/gate and gate insulator was used for storage capacitance. In this case, higher Vcom voltage is needed to make p-Si conductor. But storage capacitor's area could be decreased due to thin thickness of gate insulator.

3. Results and Discussion
To make p-Si conductor, Vcom voltage is increase

from 0~4V to -11~-7V. With this higher voltage, active/gate capacitance can be fully charged during 1 frame.

The high voltage for inducing capacitance between active (p-Si layer) and gate was successfully generated by using external charge pump circuit consisting of diode and capacitors. The normal Vcom range 0~4V and VGL (Gate on voltage for PMOS, -7V) were used. When we use VGH (gate off voltage, 11V), the resultant Vcom was 11~15V, but storage capacitance couldn't be sustained.

Fig. 1 shows the developed 2.1" qVGA landscape (320X240) model. The aperture ratio increased from 48% of conventional gate/data capacitance structure to 65%. With this high aperture ratio, the brightness was increased from 180cd to 270cd. The flicker and crosstalk levels aren't degraded from those of conventional structure. Specification of this product is shown in table 1.

Fig. 1. Photograph of 2.1" qVGA SLS-LCD

Parameter	2.1-inch panel
Panel size (mm^2)	49.2(H)X43.2(V)
Display area (mm^2)	43.2(H)×32.4(V)
Aperture ratio	65%
Pixel size (μm^2)	135(H)×135(V)
Dead space (mm)	2.0 (one side)

Fig. 2. Specification of 2.1" qVGA SLS-LCD

4. Conclusions

Active/gate capacitance can give chance to LTPS LCD in the new applications such as DMB or PMP (Portable Multimedia Player). These applications need high resolution display with high brightness and color gamut to the level of television. (200cd of brightness and 70% of color gamut) The solution for this requirement can be achieved by high aperture ratio. This technology will be used widely in future high quality TFT-LCD.

5. References

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