Large Size Plastic Display for Outdoor Application

Nam-Seok Roh*, Tae Hyung Hwang, Woojae Lee, Wang Su Hong, Sung Jin Kim, Sang Il Kim, Peter Shin
Display R&D Center, Samsung Electronics Co., Youngin-City, Gyeonggi-Do, Korea
TEL:82-31-209-7461, e-mail: colus@samsung.com.

Keywords : Plastic, amorphous silicon, TFT, reflective, E-Paper

Abstract

A A4 size black and white reflective plastic display was developed for out door application. For document readability, high resolution of 180ppi plastic TFT backplane and high reflectance electrophoretic front panel sheet was used. Preparation of display was held near 100℃ process on PEN substrate.

1. Introduction

Ubiquitous environment requires large sized display for lots of information and good optical quality in direct sunlight since outdoor application is much more needed than indoor environment. However, total size of device should be small for convenience of hand carrying. These requirements result in development of reflective display with flexibility.

The most manufactured display for mobile device in current age is liquid crystal display, witch has excellent image quality. However, as you see in Figure 1, on dark environment, normal paper has much better quality than LCD. This is why many company put efforts on developing reflective display such as electrophoretic devices.

For development of large size flexible display, active matrix must be fabricated on flexible substrate such as plastic or metal foil. We developed high resolution TFT using low temperature amorphous silicon for application of E-Paper display.

2. Development and Results

As the size of display increases, plastic substrate becomes important to control the misalignment carefully during the TFT process to fabricate a high-resolution TFT array. We made several efforts to minimize the dimensional change of plastic substrate during the TFT processes as described in previous paper[1].

We utilized PEN films of 125 um for the plastic substrate. PEN is good in various point of views such as coefficient of thermal expansion (14 ppm), highly transparent and commercially available but has relatively low glass transition temperature (Tg) of 128℃. On the other hand, another LCD manufacturer reported that a thin metal foil was used to develop ultra-thin and flexible EPD instead of plastic [2]. A very thin metal foil can utilize the high temperatures of the normal TFT processes, though it is very heavy compared to plastic and has high manufacturing cost because of planarization process for rough metal surface to be used for fine TFT process. However, for the flexible OLED applications, it's high barrier characteristics is very suitable, so many research is on progress for development of flexible OLED. For application for reflective E-Paper, plastic is much suitable.

After proper pre-process has done, the film was attached on a glass using the adhesives which can be delaminated by temperature or UV light control. And then, thin film process was progressed starting from the gate electrodes. SiNx, a-Si:H, and n+ Si:H were deposited by PECVD process at near 100 ℃ using improved TFT properties. After a-Si:H and n+ Si:H were patterned, source and drain electrodes were formed on them, followed by a dry etch of n+ Si:H. Next, organic passivation and pixel electrodes were consecutively formed to fabricate the TFT array on PEN successfully. Figure 2 shows the transfer characteristic of an a-Si:H TFT fabricated at near 100℃. After all, we developed a 14.3-inch amorphous Silicon TFT backplane on plastic with the resolution of 2060 X 1500 lines (180 ppi) using LCD pilot line as shown in Figure 3.

3. Technology Limitation

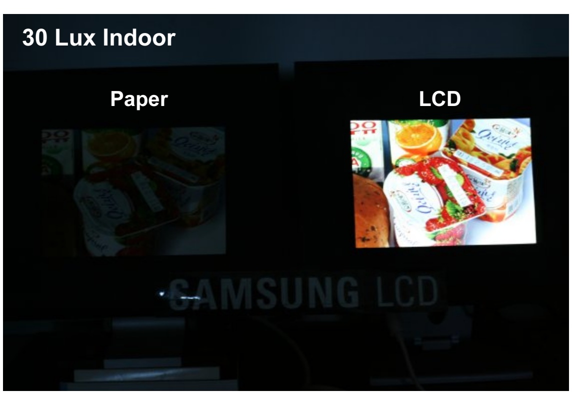
Although we made a high resolution plastic TFT backplane, the final product made by EPD sheet still has some limitations before it can be commercialized. For example, reliability of EPD sheet is not the level of consumers requirement, such as operating temperature (0 ~ 50℃). Other environmental reliability including humidity, UV resistance should be tougher to be used. Also backplane TFT must have more mechanical reliability for flexible display. All these characteristics must be solved before commercialization.

4. Summary

A A4 size black and white plastic e-Paper was developed at the resolution of 2060 X 1500 lines (180 ppi). All of the processes of TFT and EPS lamination were not only carried out below 130 , but also optimized for large area e-Paper on PEN films. Therefore, it could be very effective not only for a slim and free design of hand-carrying device such as e-Books or e-Newspaper, but also for a real flexible displays.

5. References

1. Tae Hyung Hwang, "14.3 inch Active Matrix-Based Plastic Electrophoretic Display Using Low Temperature Processes" *SID07.,* **58.3** (2007).
2. S-H. Paek et al, "A 10.1-in. SVGA Ultra-Thin and Flexible Active-Matrix Electrophoretic Display", , *SID06.,* **62.3** (2006).



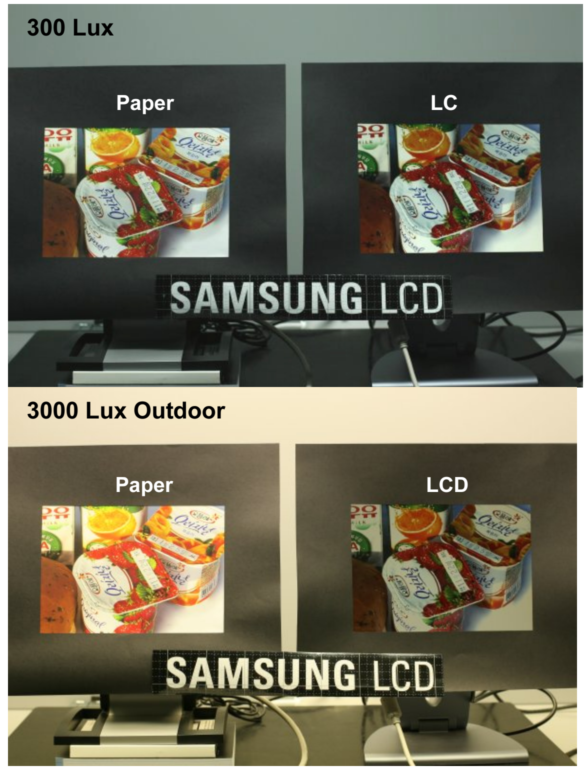


Fig. 1. Comparison of Paper and LCD

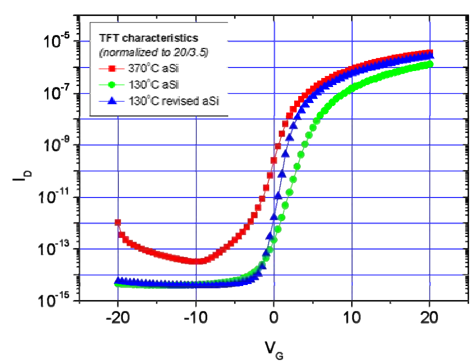


Fig. 2. The transfer characteristic of a-Si:H TFT on PES.

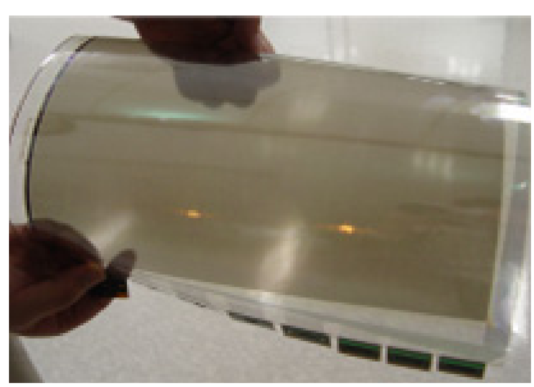


Fig. 3. TFT Backplane photograph.