Flexible OTFT-OLED Display Panel using Ag-paste for Source and Drain Electrodes

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Abstract

We fabricated OTFT-OLED display panel by using Ag-paste for source and drains electrode of OTFTs. The OTFTs were fabricated by solution processes such as spin-coating for PVP gate dielectric and screen printing for S/D electrodes with Ag-paste, except pentacene active layer which was deposited by evaporation. The mobility was 0.024 cm^2/V.sec , off state current ~10^{-11}A, threshold voltage 7.6 V and on/off current ratio ~10^5. The panel consisted of 16 x 16 pixels and each pixel consisted of 2 OTFTs, 1 Capacitor and 1 OLED. The pixels successfully worked in terms of current magnitude supplied to OLED and the control ability of driving and switching OTFTs.

1. Introduction

There has been a great deal of interest in and research on active matrix organic light emitting diode (AMOELD) because of the possibility of thinner, lighter, faster more power-efficient displays. Low-temperature poly silicon (LTPS p-Si) and amorphous silicon (a-Si) are known as semiconductors of thin film transistors (TFTs) used in AMOLED display. However, it is difficult to fabricated TFT arrays on plastic substrate because of the high-temperature process and large-scale facilities required for manufacturing. Organic TFT(OTFT) that are easily manufacturable at low temperatures are needed to replace Si-TFT. Table 1 show several groups are working on OTFT-AMOLED. Sony demonstrated flexible full color AMOLED (120 x 160) using pentacene OTFT on glass and plastic substrate. LG electronic institute of technology demonstrated OTFT-AMOELD (12 x 12) on glass substrate. Samsung SDI and SAIT also fabricated OTFT-AMOLED (120 x 3 x 64). ETRI fabricated OTFT-AMOLED on plastic substrate (PC). And Penn State Univ. also reported OTFT-AMOLED (48 x 48) on plastic substrate (PET)[1~7].

In this paper, we fabricated OTFT-OLED display panel by using Ag-paste for source and drains electrode of OTFTs because of the possibility of extremely reduced processing cost. The panel was composed of 16 x 16 pixels on the substrate in which each pixel had 2 OTFT, 1capacitor and 1OLED.

Table 1. Technical development trend of AMOLED

Year	Group	Size	Resolution	Substrate
2007	Sony	2.5”	160xRGBx120	Glass & plastic(PES)
	LG	3.5”	160 x 120	glass
	Kyung Hee Univ.	2”	128 x 64	Plastic(PES)
2006	ETRI	2"	176 x 144	Plastic(PC)
	SAIT	4.5"	192 x 64	
	Penn. State Univ.		48 x 48	glass
	Samsung SDI	4"	64(x3) x 120	
	DTC/ITRI	4.1"	32 x 32	plastic
2005	Pioneer		8 x 8	glass

2. Experimental

The OTFT-AMOLED array was designed of 16x16 pixels. Each pixel had 2OTFTs-1Cap.-1OLED in the area of 2mm x 2mm. The OTFTs used the bottom contact structure. The channel length is 50μm and the channel widths of the switching OTFT and driving OTFT are 700μm and 2100μm, respectively. An aperture ratio of OLED is 20% as shown in figure 1. Figure 2 shows a cross section of the pixel.

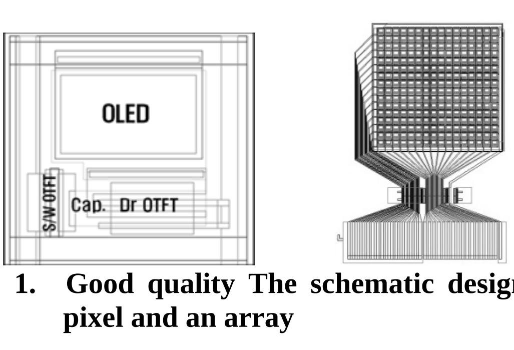

Fig. 1. Good quality The schematic design of a pixel and an array

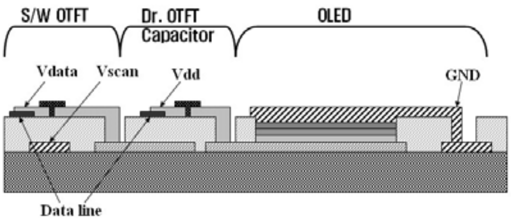

Fig. 2. The cross section of pixel

The fabrication process was as follows. The ITO pixel electrode was first patterned dfor the anode of OLED, and then the Au gate electrode was deposited on plastic substrate and patterned by lift-off process. CLA-PVP layer was spin-coated and annealed at 100℃ and 180℃, sequentially. The PVP organic gate material consisted of PVP polymer and cross-link agent (CLA), and Propylene glycol monomethyl ether acetate (PGMEA) as a solvent. We found that the optimum ratio of components was 10wt% of PVP mixed with 5wt% of CLA in 100wt% of PGMEA[8]. The CLA-PVP (gate insulator) was patterned by O_2 plasma after photo-lithography process. Subsequently, the Ag-paste solution was printed by screen printing process for source-drain electrodes. The pentacene semiconductor layer was deposited on the electrodes by thermal evaporation. For OLED, 2-TNATA, NPD and Alq3 were sequentially deposited through a shadow mask. Finally, the Al electrode was deposited for the cathode of OLEDs. Figure 3 shows fabricated 16 x 16 OTFT-AMOLED display and a pixel.

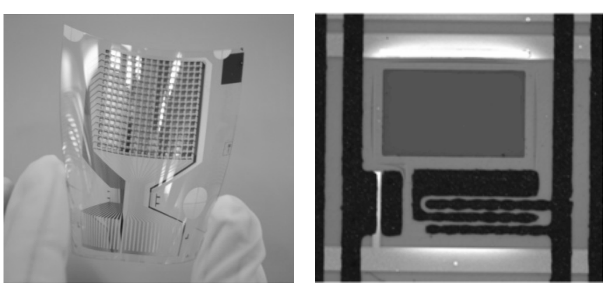

Fig. 3. The picture of fabricated 16 x 16 OTFT-AMOLED display and enlarged pixel

3. Results and discussion

In figure 4, the picture of OTFT and transfer and output curves are presented. They exhibited the typical transfer and output curve of OTFTs. The field effect mobility was 0.024 cm^2/V.sec , off state current ~10^{-11}A, threshold voltage 7.6 V and on/off current ratio ~10^5. The capacitance of fabricated capacitor is 12.23pF. The sheet resistance and thickness of Ag-paste are about 0.12Ω/□, and about 5μm, separately.

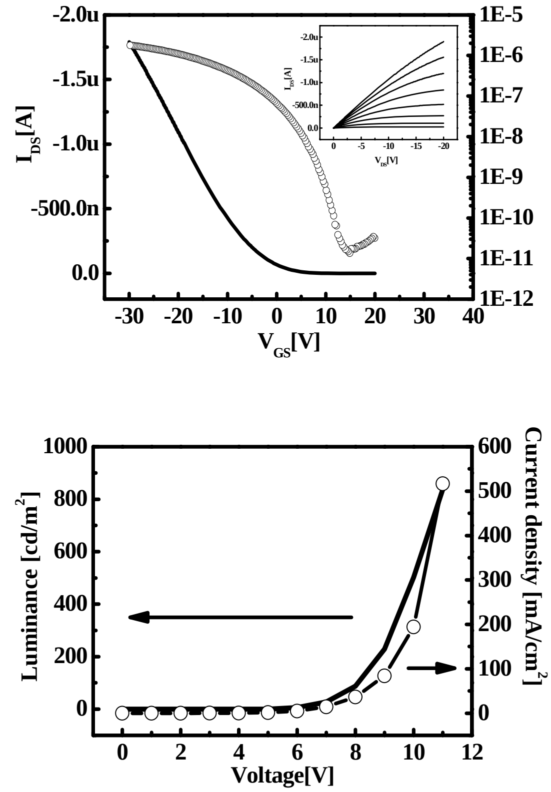

Fig. 4. The characteristics of fabricated OTFT and OLED

Figure 5 and figure 6 shows the characteristics of pixel and a photograph of 16 x 16 OTFT-AMOLED display. The pixels were successfully worked by supplying sufficient current to OLED under the control of driving and switching OTFTs.

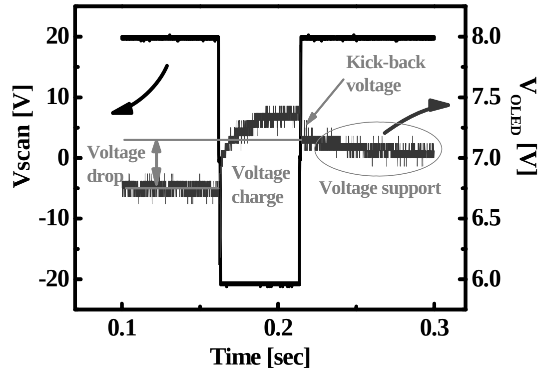

Fig. 5. The characteristics of pixel

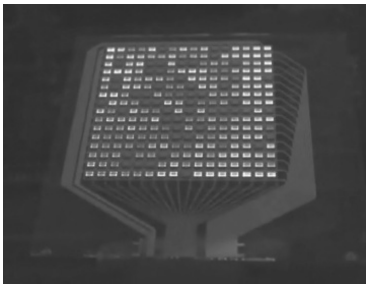

Fig. 6. The picture of driven 16 x 16 OTFT-AMOLED

4. Summary

We fabricated OTFT-OLED display panel by using Ag-paste for source and drains electrode of OTFTs. The OTFTs were fabricated by solution processes such as spin-coating for PVP gate dielectric and screen printing for S/D electrodes with Ag-paste, except pentacene active layer which was deposited by evaporation. The mobility was 0.024 cm^2/V.sec , off state current ~10^{-11}A, threshold voltage 7.6 V and on/off current ratio ~10^5. The capacitance of fabricated capacitor is 12.23pF. The sheet resistance and thickness of Ag-paste are about 0.12Ω/□, and about 5μm, separately. The panel consisted of 16 x 16 pixels on PEN substrate and each pixel consisted of 2 OTFTs, 1 Capacitor and 1 OLED. The pixels were successfully worked by supplying sufficient current to OLED under the control of driving and switching OTFTs.

Acknowledgements

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5. References

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