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A stable FHD display device based on BCE IGZO TFTs

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Abstract

In this work, the impact of the deposition process of the SiOx passivation layer on the electrical properties of the BCE IGZO TFTs has been studied. The ΔVth of the TFTs are 2.52 and -1.67 V under PBTS (60°C, 30 V) and NBITS (60°C, -30 V, 4500 nit) after 1 hour, respectively. The stability of these TFTs is verified in 32in FHD display devices, which still could display the picture properly after the 500-hour aging test at 60°C and 90% humidity. A stable FHD display device based on BCE IGZO TFTs was achieved.

1. Introduction

In recent years, the need for thin-film transistors (TFTs) with high performance has been increasing on account of the demand for ultra high definition display, low energy consumption and interactive functionality [1, 2]. A variety of technical solutions have been tried to meet these requirements. Amorphous metal oxide semiconductors (AOSs), such as Indium-Gallium-Zinc-Oxide (IGZO), Indium-Hafnium-Zinc-Oxide (IHZO) and Indium-Gallium-Tin-Oxide (IGTO), have attained great attention due to their excellent performance in cost-effective manufacturing process, good uniformity and reasonable low off-current [3-5]. Among them, IGZO has become an industry-standard channel layer because of its desirable mobility, high Ion/Ioff ratio and good long-time stability.

Numerous studies were performed to improve the performance of the IGZO TFTs. The back-channel etch (BCE) IGZO TFTs were prepared to reduce parasitic capacitance and production costs [6-8]. The effect of hot carriers on the IGZO lattice under high field strength has been studied [9]. The source/drain/active layer was split to improve TFT robustness under mechanical bending strain [10]. However, there are few reports on the influence of the deposition process of passivation layers on performance of IGZO TFTs.

In this paper, the deposition process of the SiOx passivation layer was studied to improve the stability of BCE IGZO TFTs. The TFTs were used in 32in full high definition (FHD) display devices. The stability of these devices was verified by an aging test in a high temperature and high humidity environment.

References

[1] T. Hirao, M. Furuta, H. Furuta, T. Matsuda, T. Hiramatsu, H. Hokari, M. Yoshida, H. Ishii, M. Kakegawa, Novel top-gate zinc oxide thin-film transistors (ZnO TFTs) for AMLCDs, Journal of the Society for Information Display, 15 (2007) 17-22.

[2] P. Barquinha, A. Pimentel, A. Marques, L. Pereira, R. Martins, E. Fortunato, Influence of the semiconductor thickness on the electrical properties of transparent TFTs based on indium zinc oxide, Journal of non-crystalline solids, 352 (2006) 1749-1752.

[3] S.J. Park, D.-Y. Jeon, S.-E. Ahn, S. Jeon, L. Montès, G.-T. Kim, G. Ghibaudo, Static electrical characterization and low frequency noise of a-InHfZnO thin film transistors, Thin Solid Films, 548 (2013) 560-565.

[4] X. Ding, C. Qin, J. Song, J. Zhang, X. Jiang, Z. Zhang, The influence of hafnium doping on density of states in zinc oxide thin-film transistors deposited via atomic layer deposition, Nanoscale research letters, 12 (2017) 63.

[5] T. Kamiya, K. Nomura, H. Hosono, Origins of high mobility and low operation voltage of amorphous oxide TFTs: Electronic structure, electron transport, defects and doping, Journal of display Technology, 5 (2009) 468-483.

[6] S.-M. Ge, S. Li, S.-J. Chen, X.-Y. Kong, Y.-H. Meng, W. Shi, L.-Q. Shi, W. Wu, X. Liu, Q.-M. Gan, Y. Zhao, C. Zhang, C.-Y. Chiu, C.-Y. Lee, 42-1: Development of Cu BCE-Structure IGZO TFT for a High-ppi 31-in. 8K × 4K GOA LCD, SID Symposium Digest of Technical Papers, 48 (2017) 592-595.

[7] M. Nag, M. Rockele, S. Steudel, A. Chasin, K. Myny, A. Bhoolokam, M. Willegems, S. Smout, P. Vicca, M. Ameys, Novel back - channel - etch process flow based a - IGZO TFTs for circuit and display applications on PEN foil, Journal of the Society for Information Display, 21 (2013) 369-375.

[8] H. Ohara, T. Sasaki, K. Noda, S. Ito, M. Sasaki, Y. Endo, S. Yoshitomi, J. Sakata, T. Serikawa, S. Yamazaki, 4.0-inch active-matrix organic light-emitting diode display integrated with driver circuits using amorphous In–Ga–Zn-Oxide thin-film transistors with suppressed variation, Japanese Journal of Applied Physics, 49 (2010) 03CD02.

[9] H.-W. Park, J. Bae, H. Kang, D.H. Kim, P. Jung, H. Park, S. Lee, J.U. Bae, S.Y. Yoon, I. Kang, P-3: A Study on the Hot Carrier Effect in InGaZnO

Thin Film Transistors, SID Symposium Digest of Technical Papers, 50 (2019) 1222-1225.

[10] S. Lee, Y. Chen, H. Kim, J. Kim, J. Jang, P-14: Highly Robust Oxide TFT with Bulk Accumulation and Source/Drain/Active Layer Splitting, SID Symposium Digest of Technical Papers, 50 (2019) 1263-1266.

Table and Figure captions

Table 1 Electrical parameters of the BCE IGZO TFTs with a sputtering power of B KW, a SiH4 flow rate at M sccm and a flow ratio of N2O to SiH4 at W.

Fig. 1 Cross-sectional schematic of the BCE IGZO TFTs.

Fig. 2 Transfer characteristic curves of the BCE IGZO TFTs with a SiOx passivation layer deposited by different (a) sputtering power (b) SiH4 flow rate and (c) flow ratio of N2O to SiH4.

Fig. 3 Output characteristic curves of the BCE IGZO TFT with a SiOx passivation layer deposited with a sputtering power at B KW, a SiH4 flow at M sccm and a flow ratio of N2O to SiH4 at W.

Fig. 4 (a) PBTS @ Vg=+30 V, T=60°C and (b) NBITS @ Vg=-30 V, T=60°C, I=4500 nit of the BCE IGZO TFT with a SiOx passivation layer deposited with a sputtering power at B KW, a SiH4 flow at M sccm and a flow ratio of N2O to SiH4 at W.

Fig. 5 The circuit schematic of the gate-driver on array substrates.

Fig. 6 The photograph of the display device passed the 500-hour aging test at 60°C and 90% humidity.

Table 1

Parameter	Unit	Data
V_{th}	V	1.31
SS	V/decade	0.99
I_{on}/I_{off}		4.60×10^7
μ_{fe}	cm²/Vs	7.54

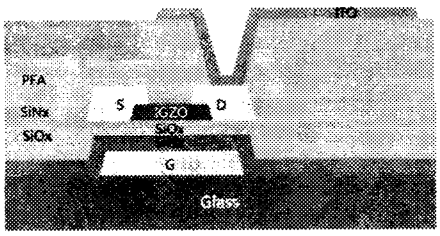

Figure 1

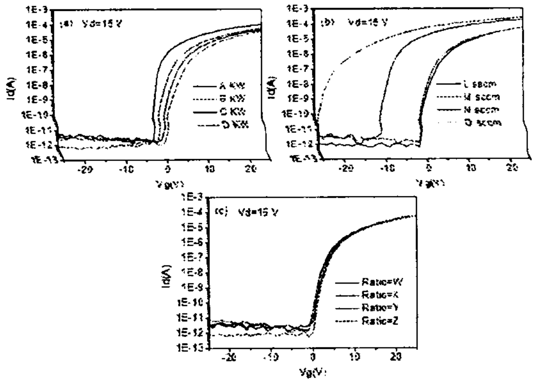

Figure 2

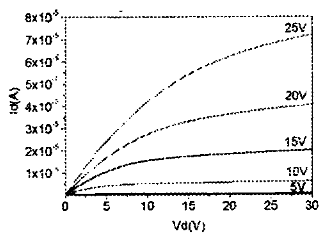

Figure 3

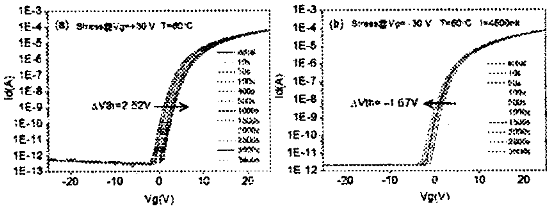

Figure 4

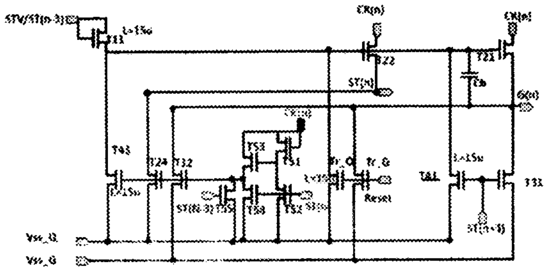

Figure 5

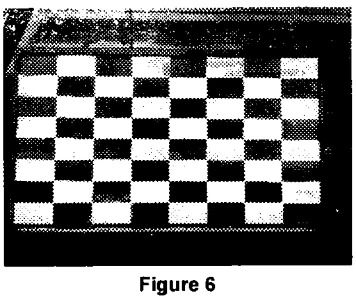

Figure 6