Beneficial Effect of Hydrogen in Aluminum Oxide Deposited by Atomic Layer Deposition Method on Electrical Properties of IGZO Thin Film Transistor

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Oxide thin film transistors (TFTs) have been intensively studied for the switching and driving elements of a display device. The electrical properties of oxide TFTs should be stable during its operation, and two mechanisms to explain the instability of electrical property of oxide semiconductor have been adopted in terms of charge trapping and defect state creation.[1] However, those mechanisms only descript the behavior of electrical instability. There are only a few essential studies to reveal the origin or source of electrical instability of oxide semiconductor and prevent it.

Herein, the role of hydrogen in the characteristics of oxide TFT is studied by changing the deposition temperature of Al_2O_3 gate insulators in the bottom-gate coplanar structure with the IGZO active layer (Fig. 1a.). The Al_2O_3 layers were grown at various temperatures of 150ºC, 250ºC, and 300ºC by means of atomic layer deposition (ALD), utilizing trimethylaluminum (TMA) and water as the Al and O sources, respectively. Fig. 1b-1d. show the transfer characteristics of the IGZO TFTs after annealing at 300ºC for 2h in a vacuum. In contrast to huge hysteresis of 7 V and 11.25 V of the TFTs with the 250ºC and 300ºC deposited Al_2O_3, respectively, the device with the 150ºC deposited Al_2O_3 shows no hysteresis. Through the analyses such as SIMS and pulsed-IV measurement, it was revealed that there were more hydrogens in the Al_2O_3 layer as process temperature was lower, and the hysteresis was mainly caused by the charge trapping. More hydrogen in the Al_2O_3 layer deposited at 150ºC could readily passivate the defects after 300ºC annealing, therefore, the transfer properties such as hysteresis and V_{th} were improved. These results suggest that hydrogen could serve a beneficial effect in terms of defect passivation.

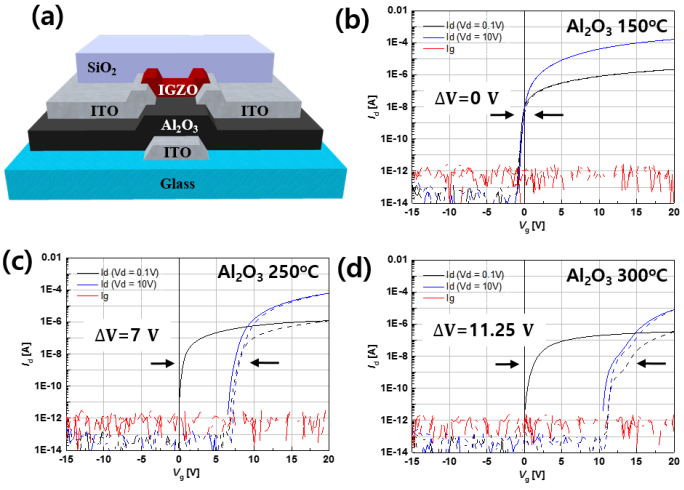

Fig. 1. (a) Schematic structure of a bottom-gate coplanar TFTs, and (b-d) their transfer curves after post-annealing at 300ºC, according to the various Al_2O_3 deposition temperature (150ºC ~ 300ºC).

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References

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