Oxide Thin-Film Transistors Using In-Ga-Zn-O Active Channels Prepared by Atomic Layer Deposition

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An amorphous In-Ga-Zn-O (IGZO) is one of the most attractive oxide semiconductors because of its advantages such as a high carrier mobilty, a superior uniformity, and a low-process temperature compatibility. So far, the IGZO has been typically prepared via sputtering method for the oxide thin-film transistor (TFT) backplanes in the flat-panel display (FPD) industries. However, the establishment of the atomic-layer deposition (ALD) process for the IGZO thin film can be a very powerful solution, considering that the ALD provides us such benefits as a precise control of film thickness and composition, an excellent conformality, and a dense and homogeneous film structure. Furthermore, these features can be uniformly obtained on a larger-size substrate; this is promising for large-area backplane applications. In this work, we fabricated the oxide TFTs using ALD-IGZO active channel and investigated on the effects of post-annealing temperature variation. This is the first report on the ALD-IGZO TFTs.

Top-gate IGZO TFTs were fabricated with following procedures. A 150-nm-thick ITO-coated glass substrate was patterned as source/drain (S/D) electrodes. An IGZO channel layer (20 nm) was deposited by ALD at 150 °C. Then, a 9-nm-thick Al_2O_3 was deposited using ALD as a protection layer for the IGZO patterning process. A 100-nm-thick Al_2O_3 gate insulator was formed by ALD at 200 °C. Finally, Al (100 nm) layer was deposited and patterned as gate electrodes and S/D pads. Post-annealing process was performed in vacuum for an hour.

Fig. 1 shows variations in transfer characteristics of the fabricated ALD-IGZO TFTs when the post-annealing temperature was varied between 200, 250, and 300 ^{o}C. It was found that the ALD-IGZO TFT treated at 250 ^{o}C showed the best performances; the carrier mobility, subthreshold slope, and threshold voltage were successfully obtained to be 12.6 $cm^2/V\cdot s$, 0.09 V/dec, and 0.3 V, respectively. These impressive results suggest that the proposed ALD process for the preparation of IGZO active channel could be very promising and inspiring for large-area backplane devices for the next-generation FPDs. The extensive investigation and analysis on the device characteristics including the device stabilities for the ALD-IGZO TFTs will be discussed at presentation.

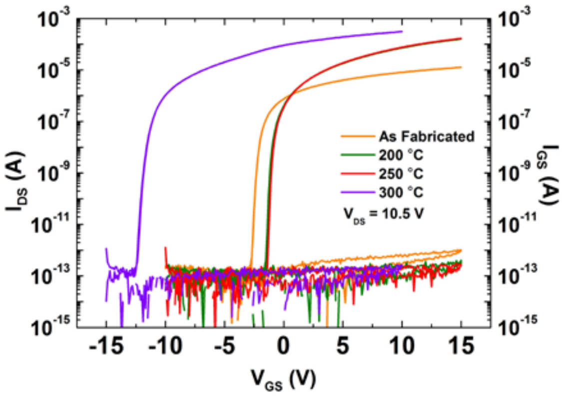

Fig. 1. Transfer characteristics of the fabricated ALD-IGZO TFTs.