Photo-annealed bilayer-channel metal-oxide thin film transistors for transparent and flexible devices

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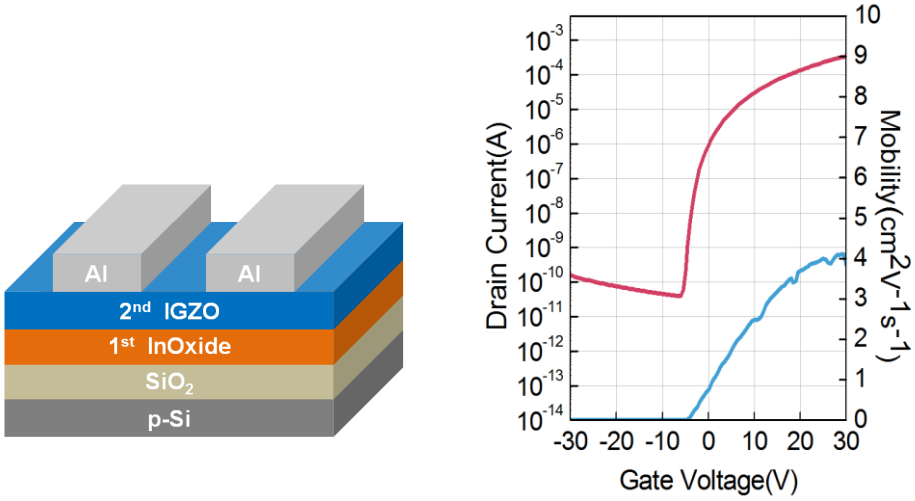
Recently, solution-processed amorphous metal-oxide semiconductor thin-film transistors (TFTs) have gained a considerable interest owing to their high electrical performance, good bias stability and possibilities to fabricate at a low temperature using photochemical activation process [1]. To further enhance their electrical performance, especially the field-effect mobility and stability, multi-layer structured channel have been reported [2]. Using a vacuum deposition process such as sputtering, multi-layer channel formation is relatively simple by sequentially depositing the desired materials without any surface engineering process. However, using a solution process, the surface characteristics of the first channel layer largely affect the coating uniformity of the second channel layer. Particularly, a thermally annealed oxide film such as InO_x shows relatively hydrophobic surface characteristics and the wetting behavior of the second channel precursor solution is very poor. Therefore, it is highly desired to have a facile route to make hydrophilic channel surface without any additional processes.

Here, we investigated multi-layer stacking of metal-oxide channels by employing photochemical activation process. It was found that compared to thermal annealing, the photo-annealed channel surface showed more hydrophilic characteristic and provide a facile multi-layer stacking without any additional surface treatment process. We fabricated a bilayer-structured oxide TFT comprising a high-conductivity first channel layer (InO_x) and a second channel layer of conventional oxide material such as indium-gallium-zinc oxide (IGZO). The more hydrophilic nature of the photo-annealed oxide surface can be attributed to additional hydroxyl groups present on the surface of the channel layer. Using a photo-annealed InO_x/IGZO bilayer channel, TFTs with field-effect mobility of 4.1 cm^2/Vs and V_{ON} of -5 V have been achieved.



(a) (b)

Fig.1. (a) Schematic illustration, and (b) transfer characteristics of photo-annealed InO_x/IGZO TFTs.

References

1. Y. H .Kim et al., *Nature*, 489, 128 (2012).
2. D. J. Kim et al., *ACS Appl. Mater. Interfaces*, 5, 4190 (2013).