Active Layer of Conductive In_2O_3 Channel Covered with ZrO_2 Insulating Thin Film in Solution Processed TFT Application

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Recent research on structure-engineered metal oxide thin film transistors (TFTs) has been focused to achieve high mobility and stability. Double-layer structure comprising conductive channel such as InZnO and InSnZnO and less conductive semiconductor layer was proposed. The role of semiconductor layer is known to either confine the flow of carrier electrons by forming the energy barrier or decrease the oxygen vacancy.[1,2]

In this study, we report an unique combination of bilayer stucture for conventional bottom-gate top-contact TFT. An In_2O_3 layer, conductive binary oxide, was employed as channel and abundant electon carriers are controlled by insulating ZrO_2 layer coated onto In_2O_3 beneath the source/drain contact. Both In_2O_3 and ZrO_2 layer were fabricated by solution-process and annealed at 400°C for 1 hour resulting in thickness of around 6 nm and 8 nm, respectively. Single In_2O_3 TFT without ZrO_2 layer is less depend on gate bias showing high current attributed to high carrier concentration. Meanwhile, in case of the In_2O_3 TFT with ZrO_2 layer represented the enhanced switching property with clear on/off state indicating that the ZrO_2 layer contols the conductivity of the channel rather than electrically passivates the current fom the channel. Furthermore, the effect of ZrO_2, which transmutes conducting into semiconducting oxide, is verified with In_2O_3 nanowire network as a channel layer. Electrospun nanowires are annealed at 600°C in oxygen atmosphere resulting in thickness of nanowire ca. 40 nm. ZrO_2 layer is coated onto nanowire network using the same method above-mentioned. The saturation mobility of In_2O_3 nanowire/ZrO_2 TFT was 15 $cm^2V^{-1}s^{-1}$ and current on/off ratio was ~10^8. Material properties of In_2O_3/ZrO_2 bilayer structure and underlying mechanism for TFT performance based on energy band structure will be discussed.

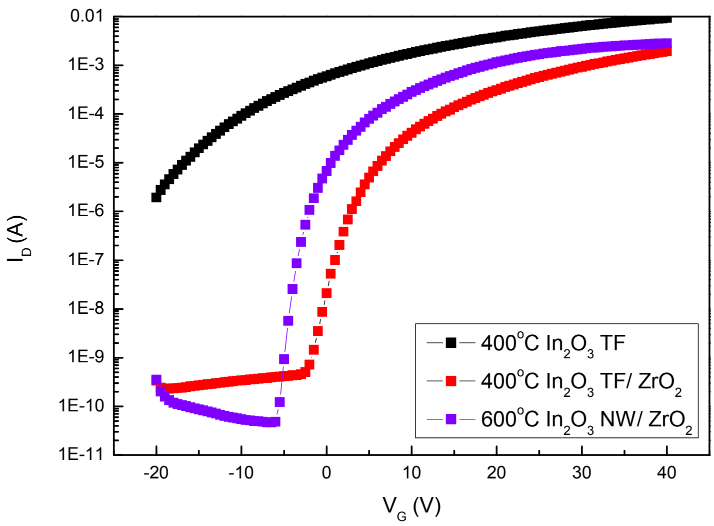

Fig. 1. Transfer curves of In_2O_3 film, In_2O_3/ZrO_2 bilayer, In_2O_3 nanowire/ZrO_2 bilayer

References

1. H. Y. Jung et al., *Sci. Report,* 4 3765 (2014).
2. Y. S. Rim et al., *Adv. Mater.,* 26 4273 (2014).