Improvement of NBTIS Stability in Sandwiched Active Structure with Al_2O_3 Interlayer in Solution Processed Oxide TFTs

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Amorphous metal oxide semiconductor (AOS) is used in thin film transistors (TFTs) for display backplanes. The advantages of AOS include high mobility, large scale uniformity and optical transparency. However, it has been widely reported that, in AOS, negative gate bias illumination stress (NBIS) and negative gate bias temperature illumination stress (NBTIS) cause a large threshold voltage shift due to the accumulation of photo-generated holes and ionized oxygen vacancies (V_o^{2+}).

In order to improve the NBIS & NBTIS-induced TFT stability, Al_2O_3 insulating layer is inserted between active fluorine doped indium zinc oxide (FIZO) [1] thin films to form a sandwiched triple layer. All the thin films were fabricated by sol-gel process. The Al_2O_3 layer acts as a photo-induced positive charge blocking layer, which effectively blocks the migration of both holes and Vo^{2+} toward the interface between gate insulator and semiconductor due to its large energy bandgap (8.4 eV) and high bonding energy with oxygen atoms [2]. The 0.01M Al_2O_3 inserted triple layer shows threshold voltage shift of -6.4 V under NBIS & -10.3 V under NBTIS. However the 0.1M Al_2O_3 inserted triple layer exhibits a noticeably lower threshold voltage shift of -0.7 V under NBIS & -3.5 V under NBTIS as well as the good TFT performance with a mobility of 10.9 $cm^2/V{\cdot}s$. We anticipate that this approach can break through the stability issues such as NBIS & NBTIS caused by inescapable oxygen vacancy.

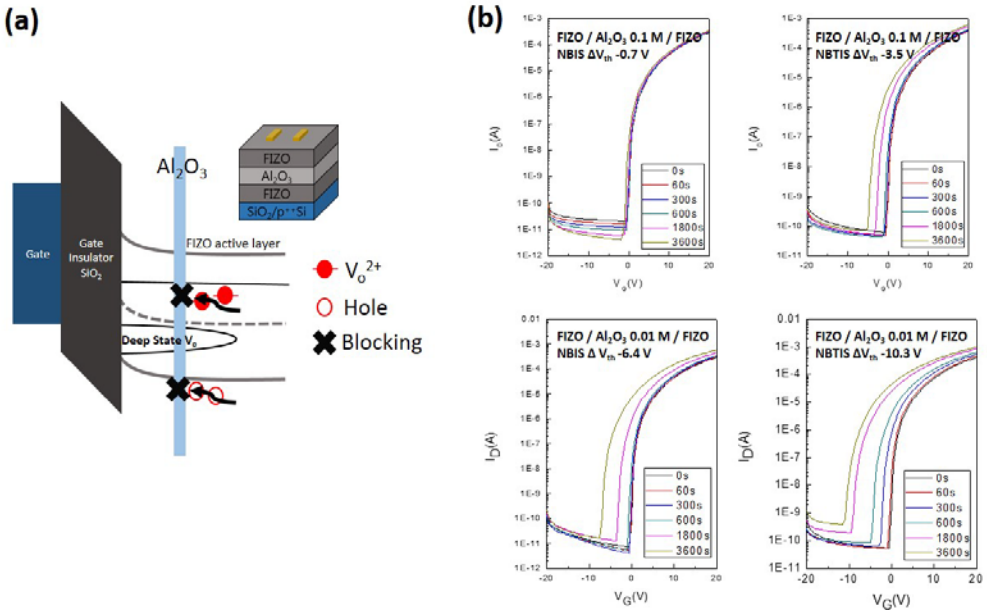

Fig 1. (a) The schematic of band diagram under NBIS & NBTIS condition and the structure of FIZO / Al_2O_3 / FIZO sandwiched triple layer (b) Changes in the I_d-V_g characteristics of FIZO / Al_2O_3 / FIZO sandwiched triple layer TFTs under -20 V gate bias stress with white light intensity of 0.3 mW/cm^2 and 60 °C.

References

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