Enhanced Stability of Indium-Tin-Gallium-Oxide Thin Film Transistors Based on Low Temperature Annealing

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Very recently, curved smart phons such as Galaxy note edge and G2 flex have been strongly attracted on display market due to their marvelous designs. Interestingly, the adopted bakplane techniqies on flexible substrate (polymide material, PI) are generally using conventional low temperature poly-silicions as active layers. Although the PI can endure high temperature process (~ 350^{o}C), the material is not suitable for practical foldable/flexible processes due to high cost and brittleness. Thus, the low temperatrue process for TFT fabrication is very necessary for genuinely flexible applications. On these days, amorphous oxide semiconductors such as In-Ga-Zn-O (IGZO) are rapidly emerging for the fabrication of thin film transistor (TFT) arrays on flexible substrates, as they exhibit higher field effect mobility than conventional amorphous silicon, and are compatible with low temperature processes[1]. However, in order to realize flexible displays, the TFT devices must be fabricated on plastic substrates such as polyethylene naphthalate (PEN) or polyethylene terephthalate (PET), which are prone to degradation upon exposure to heat. Yet, it is well known that oxide semiconductors require relatively high annealing temperatures in order to have their electrical properties activated, and the electrical defects to be reduced.

In this work, the novel In-Sn-Ga-O (ITGO) semiconductors TFTs are investigated with respect to different annealing temperatures. Counterintuitively, their stability with respect to bias stress is improved as the annealing temperature decreases. The chemical bonding states in the semiconductor layer were examined by X-ray photoelectron spectroscopy (XPS). The crystal structure of semiconductor was examined by X-ray diffraction (XRD) and transmission electron microscopy (TEM). As annealing temperature decreased, NBS instability (ΔV_{th}) also improved from -14.8V to -1.98V. ITGO TFT has sufficient reliability at relatively low temperature process, allowing the realization of flexible display on heat-sensitive plastic substrates.

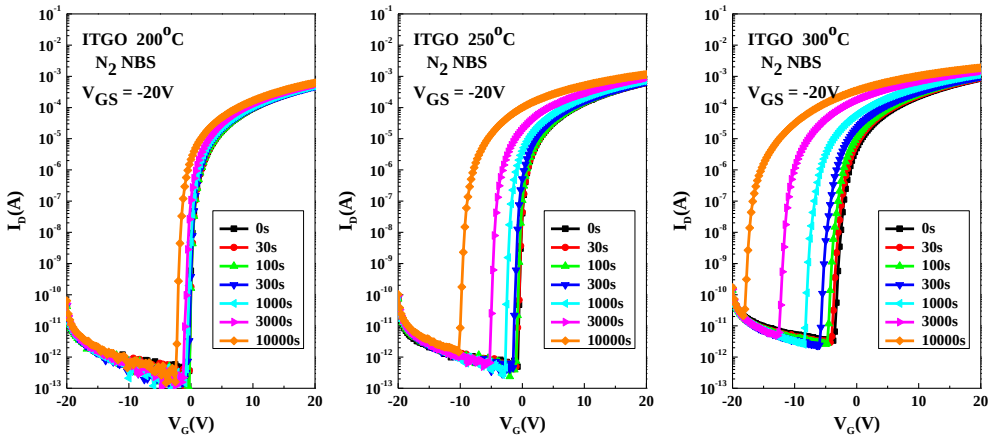

Fig. 1. Negative bias stress curves of ITGO TFT annealed at 200^{o}C, 250^{o}C and 300^{o}C (Stress time: 10,000s @ V_G=-20V)

References

1. J.S. Park et al., Appl. Phys. Lett., vol. 95, pp. 013503, (2009).