Calculation Method for Negative Bias Illumination Stress-induced Instability in Amorphous IGZO Thin-Film Transistors

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Amorphous indium-gallium-zinc oxide (IGZO) thin-film transistors (TFTs) have attracted much attention due to their advantages, such as a high field-effect mobility, low subthreshold swing, and high on-off current ratio, as promising cadidates for switching or driving devices in the field of flat panel displays [1]. However, the instability under a bias/illumination stress remains challenging problems. To date, many researchers have qualitatively studied on mechanisms of the negative bias illumination stress (NBIS)-induced instability, which have been attributed to photo-induced hole trapping, oxygen vacancy ionization, and peroxide formation models [2-4]. However, the quantitative analysis on the NBIS-induced threshold voltage (V_T) shift has not been thoroughly studied, especially in the field of applying physical long-term instability models to designing display circuits. In this work, we propose the calculation method for the NBIS-induced ΔV_T in IGZO TFTs by using experimentally extracted the process/device parameters and discuss the related instability mechanisms [Fig. 1(a)]. Particularly, we validate the proposed method by reproducing the measured NBIS-induced ΔV_T in several TFTs with varying oxygen contents of the sputtered IGZO thin-film [Fig. 1(b)]. We expect that our results make the instability-aware design of an IGZO TFT-driven display backplane as well as flexible/transparent integrated circuits for IoT era.

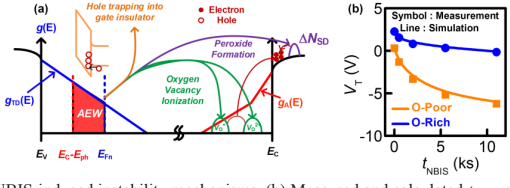

Fig 1. (a) The NBIS-induced instability mechanisms. (b) Measured and calculated t_{NBIS}-evolution of V_T.

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