[TP1-109]

Influence of the oxygen flow rate during sputter deposition on the current stress instability in bottom-gate amorphous InGaZnO Thin-Film Transistors

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Since amorphous InGaZnO (a-IGZO) thin-film transistors (TFTs) were employed in AMOLED TV manufacturing, the reliability under a long-term current stress (CS) becomes very important challenging issue [1]. On the other hand, the oxygen flow rate (OFR) during the sputtering process is widely used process parameter by which the oxygen content in a-IGZO active film is controlled. In these viewpoint, we investigate the influence of OFR on CS instability in the bottom gate (BG) a-IGZO TFTs.

The used CS conditions are W/L=200/100 μm, $V_{GS,str}/V_{DS,str}$=20/10 V, stress time (t_{STR})=1.1×10^4 s, room temperature, and a dark ambient. The OFR conditions are O_2=21, 42, and 63 sccm at the fixed Ar=35 sccm. Extracted density-of-states (DOS) was incorporated into TCAD simulation [2], the result whose suggests the lateral electric field is nearly the same regardless of the change of OFR [Fig. 1(a)]. It is also observed that the threshold voltage shift (ΔV_T) is positive value under CS and it increases as the OFR increases [Fig. 1(b)]. Since the electron trapping and donor creation are known as dominant mechanisms on CS-induced ΔV_T and the donor creation is significantly dependent on the electric-field [3], we infer that the electron trapping into gate insulator (GI) increases with the increase of OFR. It also suggests that the density of electron traps in GI (N_{OT}) increases with the increase of OFR [Fig. 1(c)]. The measured hysteresis increases with the increase of OFR [Fig. 1(d)], which in turn supports our finding that the OFR affects not only to active-film natures such as carrier density, DOS, and mobility, but also to the GI quality denoted by N_{OT} in BG a-IGZO TFTs. Our result is potentially useful for the process optimization of either the BG IGZO TFTs or AMOLED backplanes.

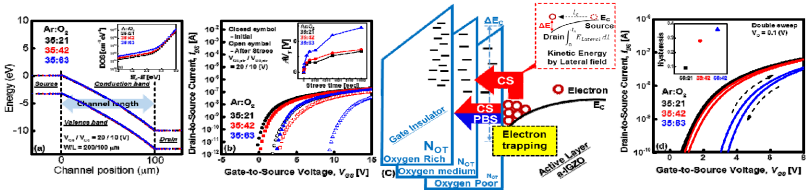

Fig. 1. (a) TCAD-simulated energy band diagram, inset: extracted DOS. (b) I_{DS}-V_{GS} curves before and after CS, inset: CS time-dependent ΔV_T. (c) Schematic illustrating the OFR-dependency of electron trapping under CS. (d) Doubly swept I_{DS}-V_{GS} curves, inset: the OFR-dependent hysteresis.

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[TP1-110]

Simulation of DC/RF Characteristics of AlInGaN/GaN HEMTs

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High electron mobility transistors (HEMTs) based on gallium nitride (GaN) have been widely investigated to replace conventional high power and high frequency electronic devices. The properties of GaN material (wide band-gap and asymmetry in a wurtzite structure) enable the HEMTs having superior properties such as high breakdown voltage, high electron mobility, high electron saturation velocity, and strong spontaneous polarization [1]. Especially, a heterostructure made by stacking a material having a wide band gap on the GaN makes a piezoelectric polarization due to their lattice mismatch [2, 3]. Spontaneous and piezoelectric polarizations make a two-dimensional electron gas channel. To overcome the inverse piezoelectric effect in the conventional AlGaN Schottky barrier layer [4,5], alternative Schottky barrier layers having the lattice matched property, such as AlInN and AlInGaN, have been studied [6]. In this work, a HEMT with an AlInGaN Schottky barrier layer has been simulated. Fig.1(a) shows the HEMT structure that has a T-shaped gate with 400 nm footprint [6]. Fig.1(b) shows the band diagram along the vertical direction. DC characteristics are shown in Figs. 1(c) and 1(d). The maximum cutoff frequency is 42GHz, as shown in Fig. 1(e). Fig. 1(f) shows the cutoff frequency as a function of Vg.

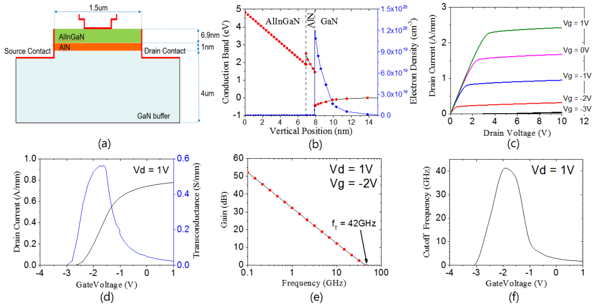

Fig. 1. (a) AlInGaN/GaN HEMT structure, (b) band diagram along the vertical direction at Vg = 0 V, (c) output characteristics, (d) transfer characteristics at Vd = 1 V, (e) gain as a function of frequency at Vd = 1 V, (f) cutoff frequency as a function of the gate voltage at Vd = 1V.

Acknowledgment:

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