Comparative Study of the Effect of Hydrogen Content on Electrical Properties of Zn-Sn-O (ZTO) and In-Ga-Zn-O (IGZO) Thin-Film Transistors

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An amorphous $InGaZnO_4$ (IGZO) thin film transistor (TFT), as a representative of oxide-based TFTs, has superior characteristics such as field-effect mobility (μ_{FE}) of ~10 cm^2/Vs. However, rare-metal of In and Ga are used in an IGZO material. In this study rare-metal free zinc tin oxide (ZTO) TFT was investigated. [1] In our previous publication, it was reported that hydrogen content in the IGZO channel influenced threshold voltage (V_{th}) and sub-threshold swing (*S.S.*) of the TFT, and it could be controlled by the nitrous-oxide/silane (N_2O/SiH_4) gas ratio during the SiO_x etch-stopper (ES) layer deposition. [2]

In this research, the effect of hydrogen in channel on electrical properties of the ZTO TFT was compared with that of the IGZO TFT. To compare the effect of hydrogen on electrical properties of the TFTs, IGZO (In:Ga:Zn=1:1:1 at.%) and ZTO (Zn:Sn=2:1 at.%) were utilized as the channel of bottom-gate TFTs. After preparing the channel layer, an etch-stopper (ES) of SiO_x was deposited on top of the channel by plasma-enhanced chemical vapor deposition used SiH_4, N_2O, and nitrogen as source gases. To control hydrogen content in the channel, N_2O/SiH_4 gas ratio was varied during the ES-SiO_2 deposition.

Fig. 1 shows the variation of transfer characteristics of ZTO and IGZO TFTs with different N_2O/SiH_4 gas ratio of the ES-SiO_x deposition. The V_{th} of ZTO and IGZO TFTs shifted negative V_{GS} direction when the N_2O/SiH_4 gas ratio decreased. Fig. 2 shows V_{th} and *S.S.* of the ZTO and IGZO TFTs as a function of N_2O/SiH_4 gas ratio of ES deposition. The V_{th} of ZTO and IGZO TFTs exhibited similar tendency when N_2O/SiH_4 gas ratio was reduced. While the *S.S.* of ZTO TFT was quite steeper than that of the IGZO TFT. Moreover, it is noted that when N_2O/SiH_4 gas ratio decreased, the *S.S.* almost unchanged for ZTO TFTs, whereas that for IGZO TFTs improved gradually. These results suggest that the effect of hydrogen or hydrogen content in the channel was different between the ZTO and IGZO TFTs. Thus, the hydrogen contents in the ZTO and IGZO channels were quantitatively analysed by secondary ion mass spectrometry (SIMS) to investigate the effect of hydrogen in more detail.The influence of hydrogen on electrical properties of ZTO and IGZO TFTs will be presented at the conference.

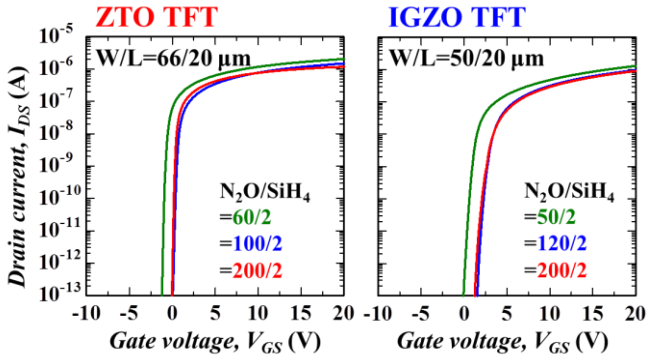

Fig. 1 Transfer characteristics of ZTO and IGZO TFTs with SiO_x-ES layer deposited at different N_2O/SiH_4 gas ratio.

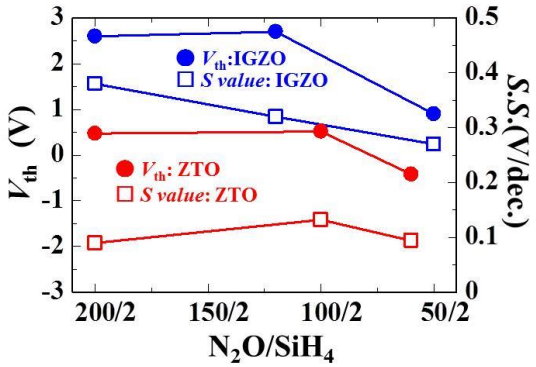

Fig. 2 The V_{th} and *S.S.* of the ZTO and IGZO TFTs as a function of N_2O/SiH_4 gas ratio during SiO_x-ES deposition.

References

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