Electrical properties Improvement of Top Gate *a*-IGZO Thin-Film Transistor using Solution Gate Insulator by Ultraviolet-Ozone and Thermal Treatment

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Electronic devices using a-InGaZnO thin-film transistors (TFTs) have been emerging in next generation displays. To reduce the production cost, some layers of the TFT structure have been replaced by solution processed materials such as channel layer, gate insulator (GI), or electrode [1]. However, it is difficult to control the chemical uniformity or defects of solution processed materials which cause low yield and low performance [1]. To solve this problem, applying ultraviolet-ozone (UV/O_3) treatment with appropriate temperature is an option.

We fabricated top gate TFT using siloxane hybrid polymers as a GI. UV/O_3 treatment after TFT fabrication is able to enhance the electrical characteristics of the film.

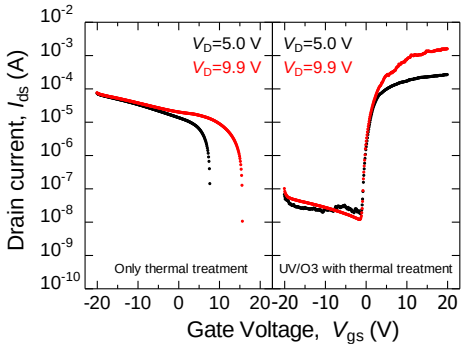

Fig. 1. Transfer characteristics of 2 conditions between without UV/O_3 at 300˚C

In this research, we compare a UV/O_3 treatment ($\lambda = 254$ nm) combined with a thermal treatment with other conditions such as without UV/O_3 at room temperature (RT), UV/O_3 at RT, UV with 300°C, and without UV/O_3 at 300°C in improving the performance of a-InGaZnO TFTs with siloxane GI.

We demonstrate the comparison of TFT characteristics between 2 conditions; TFTs treated by thermal treatment at 300°C and TFTs treated by UV/O_3 treatment with temperature at 300°C in Figure 1. Unoptimized TFTs subjected to only thermal treatment show poor characteristics – with no switching behavior and high off-current. Meanwhile, TFTs treated by UV/O_3 at 300°C show effective switching behavior. The TFT characteristics with UV/O_3 at 300°C was measured and the resulting TFT was excellent; the mobility was 12 $cm^2 \cdot V^{-1} \cdot s^{-1}$, sub-threshold swing (*SS*) was 215 mV/decade, and on-off current ratio (I_{on}/I_{off}) was 10^5.

We suggest that the UV/O_3 treatment with temperature at 300°C decreases the amount of carbon residues and defect sites related to oxygen vacancies and increased metal oxide bonds between the siloxane GI and *a*-InGaZnO which effectively improved the TFT's electrical characteristics [2]. For a deeper understanding of the detailed mechanism, chemical bonding and composition changes will be examined through X-ray Photoelectron Spectroscopy and Secondary Ion Mass Spectrometry analysis.

1. J. Zhuang et al., *Appl. Matt & Int.* **8**, 45 (2016).
2. Y. Osada et al., *IDW (2014)*.