

## Analysis of Oxygen vacancies in the Interface of amorphous InGaZnO / Siloxane passivation film by X-ray photoelectron spectroscopy

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### 1. Introduction

The electronic devices using a-InGaZnO thin-film transistors (TFTs) have been emerging as a next generation display. However, a-InGaZnO TFTs are not stable in environment because of ambient effects. For this case, the passivation is necessary for a-InGaZnO TFT to improve the TFT reliability.

Siloxanes polymers can be used for making passivation material. These organic-inorganic hybrids based on Si-O backbone can combine many desirable properties of conventional organic and inorganic components. Siloxane was one of the best selected candidate to fabricate passivation layer than another passivation because of good thermal resistance and good transparency.

The stability of a-InGaZnO TFT was improved after passivation with siloxane-based material [1]. One of reason is siloxane passivation can make oxygen bonding at the interface more stronger, controlling the amount of oxygen vacancies which causes of making electron trap at the shallow state in a-InGaZnO. However, the bonding state at the interface between the passivation and the channel layer to improve the TFT characteristics has not yet clearly.

In this research, we studied the mechanism of stability improvement explained by O1s peak in each depth layer of passivated TFT compared with unpassivated TFT using X-ray Photoelectron Spectroscopy (XPS).

### 2. Experimental

Substrate materials were made by highly conductive n-type Si substrates with a thermally oxidized layer of 100-nm-thick SiO<sub>2</sub>. Deposition of 70-nm-thick a-InGaZnO layer by RF magnetron sputter at room temperature was carried out. Post annealing treatment at 300°C for 120 min in the ratio of N<sub>2</sub>/O<sub>2</sub> (4/1) ambient atmospheres.

Siloxane polymer was spin-coated on TFTs. Prebaking was then performed at 110 °C for 1 min. To remove the volatile and finish the cross-linking reaction of siloxane, two-step baking was performed under N<sub>2</sub> atmosphere at 230°C for 20 min and 350°C for 20 min. Post annealing treatment at 300°C for 120 min in the ratio of N<sub>2</sub>/O<sub>2</sub> (4/1) ambient atmospheres finished to make

a-InGaZnO TFTs with passivation layer. To analyze the interface between siloxane passivation and a-InGaZnO layer, the passivation surface was etch by a reactive ion etching process. The TFTs with/without passivation were analyzed by XPS with depth profile to summarize a changing of oxygen vacancies at the interface and in the layer.

### 3. Results and Discussion

Figure 1 showed the interface analysis of O 1s XPS profiles revealed the emergence of a 3rd peak in passivated samples at ~ 532 eV which is attributed to the peak related to hydroxide. Both passivated and unpassivated samples had two peaks at ~ 531 and ~ 530 eV which is attributed to oxygen deficiency region and oxygen bonding with metal, respectively [1]. The amounts of oxygen deficiency region can present by area ratio of peaks (the peak area related oxygen deficiency region divided by all peak area). The unpassivated TFTs exhibited lower value than that of the passivated TFTs (48%→34%), suggesting the siloxane-passivation can reduce the amount of oxygen vacancies at the interface. Decreasing of oxygen vacancies was confirmed as decreasing of electron trap which improve the stability of a-InGaZnO TFTs [2].

We will explain the effect of our passivation layer to the oxygen vacancies in depth direction of a-InGaZnO layers that can be the key for improve the stability of a-InGaZnO TFTs.

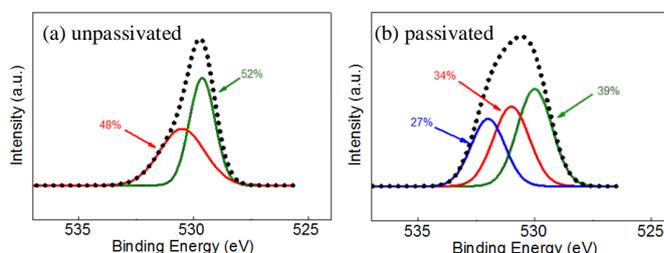


Fig. 1 XPS profiles revealed the peaks at ~ 532, ~ 531 and ~ 530 eV attributed to hydroxide peak, oxygen deficiency region and oxygen bonded with metal, respectively

### 4. References

- [1] J. P. Bermundo *et al.*, ECS J. Solid State Sci. Technol. **3**, Q16 (2014)
- [2] R. Tang *et al.*, Nanoscale Res. Lett., **8**, 368 (2013)