Defect Analysis of Siloxane Gate Insulator and its Interface in *a*-IGZO Thin-Film Transistor

Nara Institute of Science and Technology, ○Chaiyanan Kulchaisit, Juan Paolo Bermundo, Mami N. Fujii, Yasuaki Ishikawa, and Yukiharu Uraoka

E-mail: chaiyanan-ku@ms.naist.jp

Siloxane materials were developed to improve the performance of Amorphous Indium Gallium Zinc Oxide Thin Film Transistor (*a*-IGZO TFT) [1]. Siloxane has become a candidate for making film layer for TFTs because of its good transparency and high thermal resistance [2]. We demonstrate how siloxane improves the TFT characteristics and reliability as both passivation layer and gate insulator roles which can be used in printable, flexible, and transparent devices in the future. We fabricated dual gate TFT which has siloxane acting as a passivation or gate insulator depending on whether the bottom gate or top gate is characterized, respectively. Previously, we showed that the *a*-IGZO TFT bottom gate structure passivated with siloxane improve reliability [2]. Moreover, *a*-IGZO TFT top gate structure with siloxane gate insulator also have good TFT switching behavior and excellent hysteresis results as shown in Fig. 1 (a). But repeatability yield is very low (around 10%), we suggest that defects from the interlayer between siloxane and IGZO layer may affect the TFT characteristics.

In this study, we focus on the cross-sectional observation of *a*-IGZO TFT top gate structure by Scanning transmission electron microscopy (STEM) in order to understand how to improve the top gate TFT characteristics with siloxane as a gate insulator. Fig. 1 (b and c) shows the cross-section of the TFT by STEM, showing the thickness difference of siloxane layer at different areas in the same sample. Fig. 1 (c) showed a defect zone occurred between siloxane and IGZO layer. For the gate insulator, the thickness is important such that a thinner insulator has a larger capacitance and contains smaller amounts of total trap centers compared with thicker dielectrics [3]. The common defects such as oxide, border, and interface traps led to unstable TFT characteristics. We showed that these thickness differences and defects on the interlayer affects the characteristic of TFTs with siloxane gate insulator.

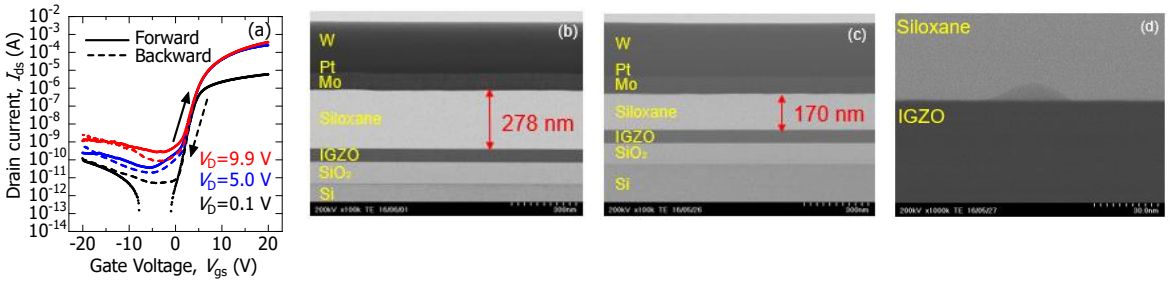

Fig. 1. (a) Transfer characteristics of top-gate *a*-IGZO TFT showing switching behavior, hysteresis loop, (b and c) STEM observation of the *a*-IGZO TFT structure with siloxane layer showing the thickness difference at different areas and (d) defects occurred between siloxane and IGZO layer.

1. K. Nomura et al., *Appl. Phys. Lett.* 93, 192107 (2008).
2. C. Kulchaisit et al., *J. Disp. Tech.* 12, issue 3, p. 263-267 (2016).
3. X. Ding et al., *Mat. Sci. Semicon. Proc.* 29, 326-330 (2015).