Highly Reliable Low Temperature (180°C) Solution Processed Passivation for Amorphous Solution Processed In-Zn-O Thin-Film Transistors

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Recently, amorphous oxide semiconductors (AOS) have been widely studied due to their remarkable properties which are high electrical characteristics, low fabrication temperature, and large area deposition[1)]. However, unpassivated AOS thin film transistors (TFTs) show degradation in important parameters including the threshold voltage (V_{th}), subthreshold swing (*SS*), and off current (I_{off}) when exposed to humid condition[2)]. In this study, the organic–inorganic hybrid polysilsesquioxane (PSQ) passivation was used as the passivation layer to protect AOS TFTs from degradation. These organic–inorganic hybrid passivation materials are composed of a SiO polymer backbone with methyl and phenyl as the alkyl groups. It has been demonstrated as an effective passivation material for AOS TFTs at temperatures as low as 180℃[3)]. In this work, we investigate the reliability of amorphous indium zinc oxide (*a*-IZO) TFTs passivated with low temperature (180 °C) PSQ against positive bias stress (V_{gs}=+20V), negative bias stress (V_{gs}=-20V), and additional humidity stress test at relative humidity of 98% and temperature of 30°C for 2 h (V_{gs}=V_{ds}=0V).

Bottom gate top contact solution processed *a*-IZO TFTs were fabricated with Mo/Pt as source and drain electrodes. Then, PSQ thin films were deposited as passivation by spin coating and were post-baked at 180ºC for 1 h. Improvement in electrical characteristics after passivation was clearly observed in the transfer curves (I_d-V_g) as the linear mobility (μ) of unpassivated sample increased from 5.03 cm^2/Vs to 6.35 cm^2/Vs and the V_{th} also shifted closer to 0 V. This is likely due to a high amount of hydrogen in the passivation that can occupy the oxygen vacancies site in the *a*-IZO bulk[4)]. Figure 1 shows the transfer curves of unpassivated and PSQ-passivated samples before and after humidity stress. Based on these results, TFTs incorporated with PSQ passivation show excellent barrier capabilities as observed in the slightly smaller hump compared to unpassivated sample. This is predictable as the adsorption of moisture and oxygen at the back channel of unpassivated sample can act as electron donors or electron acceptors, thus changing the V_{th} and *SS* values. These results show that the adoption of low temperature PSQ passivation not only prevents *a*-IZO TFTs degradation under humid condition but also improve the electrical performance of *a*-IZO TFTs.

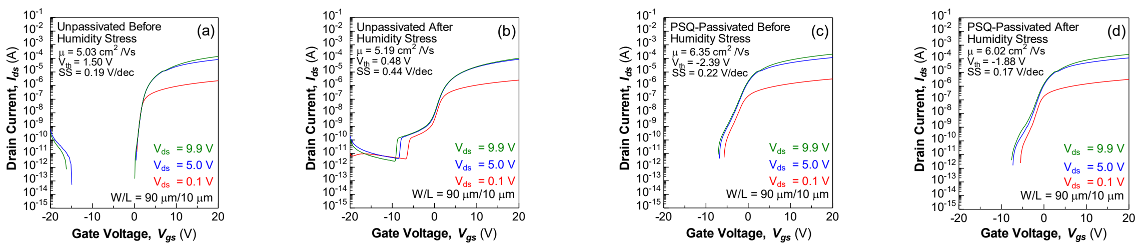

Fig 1. I_d-V_g curves of unpassivated and PSQ-passivated *a*-IZO TFT (a, c) before and (b, d) after humidity stress.

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References

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