Amorphous HfInZnO Thin Film Transistors for Use in Harsh Environment

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The rise of space program has stimulated the demand in developing technology for outer space use. Radiation damage and gigantic variation in temperature are major issues while applying electronic devices in space mission. Proton bombardment on electronics causes the degradation of the material conductivity due to the formation of additional electron traps.[1] In addition, when increasing temperature, oxygen atoms are thermally excited which leave their original sites and then causes vacancies.[2] In this study, we investigate the method to engineer the electrical properties of InZnO-based transistors (IZO TFTs) and explore the way to stabilize them as operated in harsh environment. Generally, an effective approach to stabilize the IZO TFT is to implant metal cations such as Gallium (Ga^{3+}), Magnesium (Mg^{2+}), Hafnium (Hf^{4+}), Tin (Sn^{4+}) and Zirconium (Zr^{4+}).[3] We show that by modifying the Hf ratio the electrical properties of InZnO-based thin film transistors, i.e. HIZO TFT (Fig. 1), can be tuned. Moreover, subthreshold swing (SS) degradation and a negative threshold voltage (V_{th}) shift due to proton bombardment and high temperature are observed in the transfer curves; however, the TFTs with appropriate addition of Hf shows better stability and performance. It shows that the addition of Hf ions can suppress the formation of oxygen vacancy and stabilize the film's atomic structure as well as electrical properties.[4] As a result, reducing oxygen vacancy generation not only restrains SS degradation but also significantly improves the bias stress stability in HIZO TFTs operated in harsh environment.

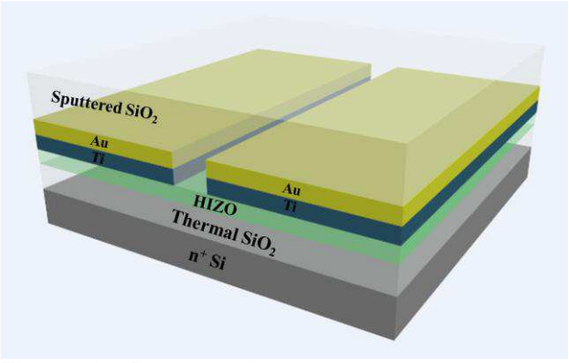

Figure 1. Structure of the bottom-gate top-contact amorphous-HIZO TFTs used in this study.

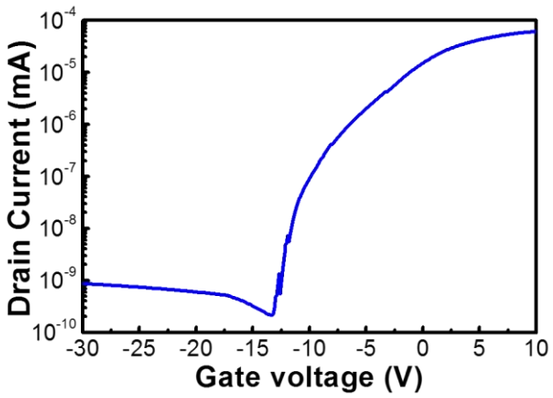

Figure 2. Transfer curve of a-HIZO TFTs.

References

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