P2-P004

Hafnium doping effect in a zinc oxide channel layer for improving the bias stability of oxide thin film transistors

Yeon-Keon Moon, Woong-Sun Kim, Sih Lee, Byung-Woo Kang, Kyung-Taek Kim, Se-Young Shin, and Jong-Wan Park

Department of Materials Science and Engineering, Hanyang University, 17 Haengdang-dong, Seoungdong-ku, Seoul 133-791, Korea

ZnO-based thin film transistors (TFTs) are of great interest for application in next generation flat panel displays. Most research has been based on amorphous indium-gallium-zinc-oxide (IGZO) TFTs, rather than single binary oxides, such as ZnO, due to the reproducibility, uniformity, and surface smoothness of the IGZO active channel layer. However, recently, intrinsic ZnO-TFTs have been investigated, and TFT- arrayss have been demonstrated as prototypes of flat-panel displays and electronic circuits. However, ZnO thin films have some significant problems for application as an active channel layer of TFTs; it was easy to change the electrical properties of the i-ZnO thin films under external conditions. The variable electrical properties lead to unstable TFTs device characteristics under bias stress and/or temperature.

In order to obtain higher performance and more stable ZnO-based TFTs, HZO thin film was used as an active channel layer. It was expected that HZO-TFTs would have more stable electrical characteristics under gate bias stress conditions because the binding energy of Hf-O is greater than that of Zn-O. For deposition of HZO thin films, Hf would be substituted with Zn, and then Hf could be suppressed to generate oxygen vacancies.

In this study, the fabrication of the oxide-based TFTs with HZO active channel layer was reported with excellent stability. Application of HZO thin films as an active channel layer improved the TFT device performance and bias stability, as compared to i-ZnO TFTs. The excellent negative bias temperature stress (NBTS) stability of the device was analyzed using the HZO and i-ZnO TFTs transfer curves acquired at a high temperature (473 K).

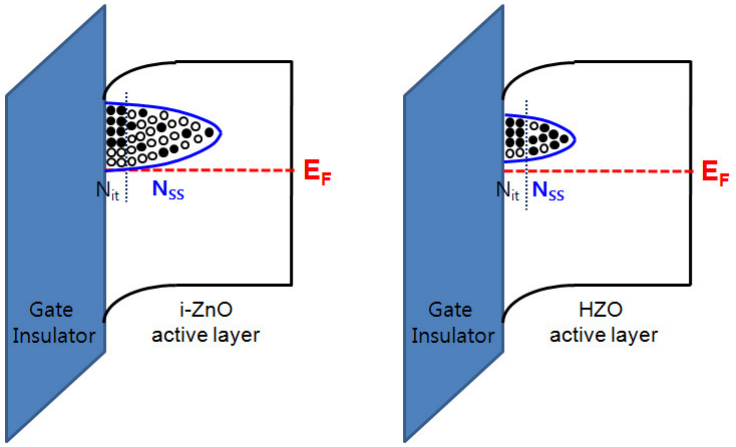

Figure 1. Rough schematic energy band diagram with density of state (DOS) for the i-ZnO and HZO-TFT.

Keywords: oxide semiconductor, active channel layer, thin film transistor, zinc oxide, hafnium doping, bias stability