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The Effects of Doping Hafnium on Device Characteristics of SnO_2 Thin-film Transistors

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Recently, Thin film transistors (TFTs) with amorphous oxide semiconductors (AOSs) can offer an important aspect for next generation displays with high mobility. Several oxide semiconductor such as ZnO, SnO_2 and InGaZnO have been extensively researched. Especially, as a well-known binary metal oxide, tin oxide (SnO_2), usually acts as n-type semiconductor with a wide band gap of 3.6 eV. Over the past several decades intensive research activities have been conducted on SnO_2 in the bulk, thin film and nanostructure forms due to its interesting electrical properties making it a promising material for applications in solar cells, flat panel displays, and light emitting devices. But, its application to the active channel of TFTs have been limited due to the difficulties in controlling the electron density and n-type of operation with depletion mode.

In this study, we fabricated staggered bottom-gate structure SnO_2-TFTs and patterned channel layer used a shadow mask. Then we compare to the performance intrinsic SnO_2-TFTs and doping hafnium SnO_2-TFTs. As a result, we suggest that can be control the defect formation of SnO_2-TFTs by doping hafnium. The hafnium element into the SnO_2 thin-films maybe acts to control the carrier concentration by suppressing carrier generation via oxygen vacancy formation. Furthermore, it can be also control the mobility. And bias stability of SnO_2-TFTs is improvement using doping hafnium. Enhancement of device stability was attributed to the reduced defect in channel layer or interface. In order to verify this effect, we employed to measure activation energy that can be explained by the thermal activation process of the subthreshold drain current.

Keywords: SnO2, bias stability, thin-film transistors