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Improvement in the Negative Bias Stability on the Water Vapor Permeation Barriers on ZnO-based Thin Film Transistors

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In recent days, advances in ZnO-based oxide semiconductor materials have accelerated the development of thin-film transistors (TFTs), which are the building blocks for active matrix flat-panel displays including liquid crystal displays (LCD) and organic light-emitting diodes (OLED). In particular, the development of high-mobility ZnO-based channel materials has been proven invaluable; thus, there have been many reports of high-performance TFTs with oxide semiconductor channels such as ZnO, InZnO (IZO), ZnSnO (ZTO), and InGaZnO (IGZO). The reliability of oxide TFTs can be improved by examining more stable oxide channel materials. In the present study, we investigated the effects of an ALD-deposited water vapor permeation barrier on the stability of ZnO and HfZnO (HZO) thin film transistors. The device without the water vapor barrier films showed a large turn-on voltage shift under negative bias temperature stress. On the other hand, the suitably protected device with the lowest water vapor transmission rate showed a dramatically improved device performance. As the value of the water vapor transmission rate of the barrier films was decreased, the turn-on voltage instability reduced. The results suggest that water vapor related traps are strongly related to the instability of ZnO and HfZnO TFTs and that a proper combination of water vapor permeation barriers plays an important role in suppressing the device instability.

Keywords: ZnO-based TFT, Water vapor permeation barrier, Negative bias temperature instability (NBTI)