High Performance Thin-film Transistors with Hybrid-phase ITO-stabilized ZnO Active Channel Layer

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The advancement of displays towards large area and ultrahigh definition claim thin film transistors (TFTs) with higher electrical performance, uniformity and stability. The most prevalent a-IGZO is theoretically limited by its composition and randomness, and seems insufficient to provide demanded mobility (> 20 cm^2/Vs) [1]. Binary ZnO suffers from instability issues that related to native defects [2]. In this paper, we propose the ITO-stabilized ZnO thin film with less native defects, and introduce a novel hybrid-phase microstructure, where nanocrystals are embedded in an amorphous matrix. The proposed thin film can provide relatively high mobility and stability.

Following a sufficient study on microstructural and electrical properties of hybrid-phase ITO-stabilized ZnO thin films, both staggered bottom-gate and top-gate TFTs with this optimal ITO-stabilized ZnO channel layers are fabricated, and exhibit a fairly high electrical performance especially in field-effect mobility and subthreshold swing. Additionally, the electrical performance of devices is proved to be spatially uniform and stable.

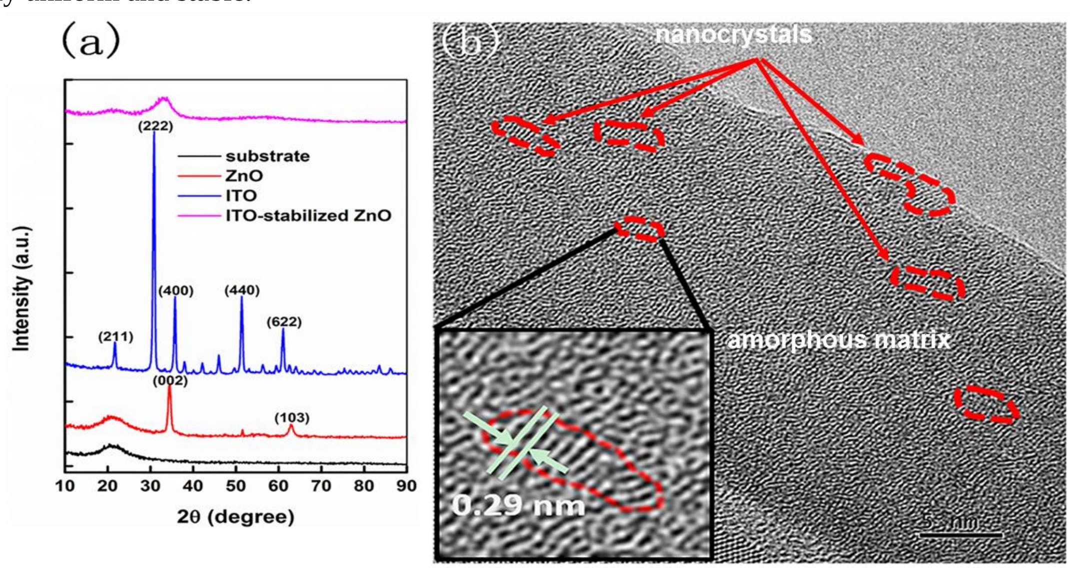

Figure 1. a) XRD spectra of polycrystalline ZnO and hybrid-phase ITO-stabilized ZnO thin films deposited on thermal-oxide-coated silicon wafers; b) HRTEM cross-sectional image of hybrid-phase ITO-stabilized ZnO thin films cosputtered on silicon wafers with (100) orientation.

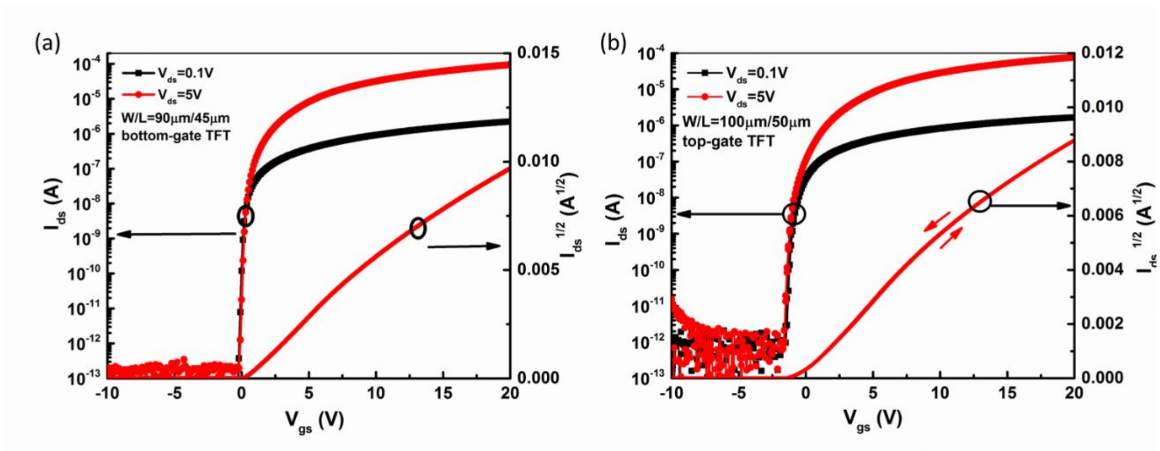

Figure 2. Transfer curves of the staggered a) bottom-gate and b) top-gate TFTs with optimal hybrid-phase ITO-stabilized ZnO channels.

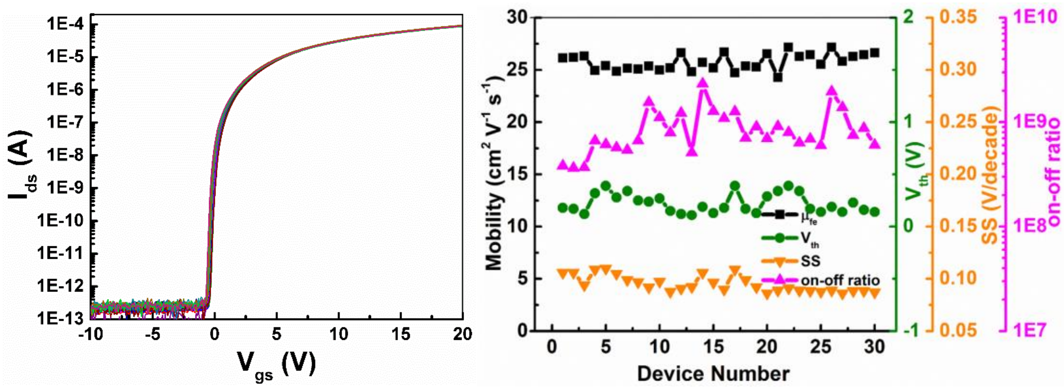

Figure 3. Spatial device uniformity of 30 bottom-gate ITO-stabilized ZnO TFTs, which are uniformly distributed over a 4-inch silicon wafer.

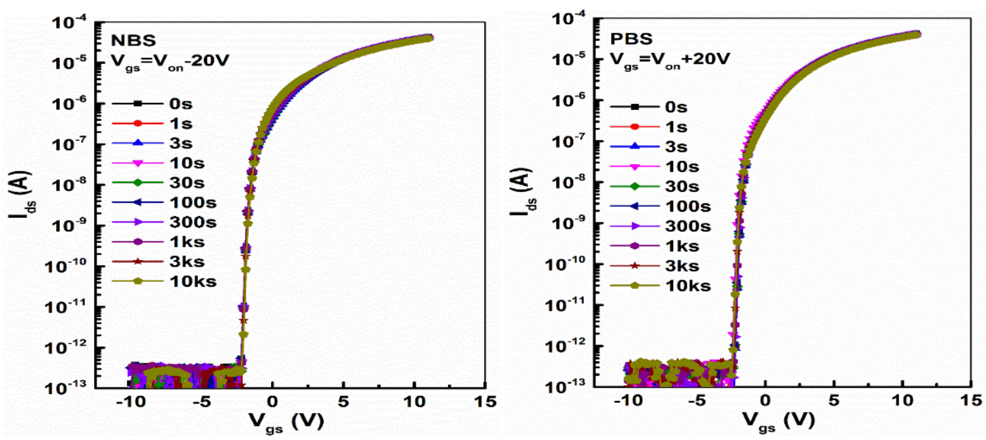

Figure 4. Transfer curve evolution of top-gate ITO-stabilized ZnO TFTs for (a) NBS and (b) PBS

Reference:

[1] K. A. Stewart, B.-S. Yeh, J. F. Wager, "Amorphous Semiconductor Mobility Limits." *J. Non. Cryst. Solids*, vol. 432, pp. 196-199, Oct. 2016.

[2] E. Fortunato, P. Barquinha, R. Martins, "Oxide semiconductor thin-film transistors: a review of recent advances." *Adv. Mater.*, vol. 24, pp. 2945-2986, June 2012.