Silicon doped amorphous Indium Oxide thin film transistor for low-power consumption flat panel display

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Amorphous metal oxide thin-film transistors (TFTs) are fabricated using InOx-based thin films doped with TiO_2, WO_3 or SiO_2. The electrical properties of the TFTs showed strong dependence on the dopant species. We found that the dependence could be reasonably explained by the bond-dissociation energy. By incorporating the dopant with higher bond-dissociation energy, the film becomes less sensitive to oxygen partial pressure used during sputtering deposition and remains electrically stable to thermal annealing treatment. The concept of bond-dissociation energy can contribute to the realization of more stable metal oxide TFTs for flat panel displays.
Among the doped In_2O_3-based thin films, we focus on silicon induced metal oxide this film transistors (SiM-OxTFTs). The amount of doped silicon in amorphous In_2O_3-based thin films is found to suppress the formation of unstable oxygen vacancies. The SiM-OxTFTs exhibited reliable device characteristics after being annealed at 250 ℃. Increasing the SiO_2 content of the sputtering target decreased the sensitivity of the subthreshold swing and turn-on voltage of the device to the sputtering conditions used to deposit the amorphous oxide, making them more stable against electrical and thermal stresses. The increased activation energy of the charge carriers in the current off region indicated a smaller density of states at the conduction-band tail, supporting stable transistor operations.

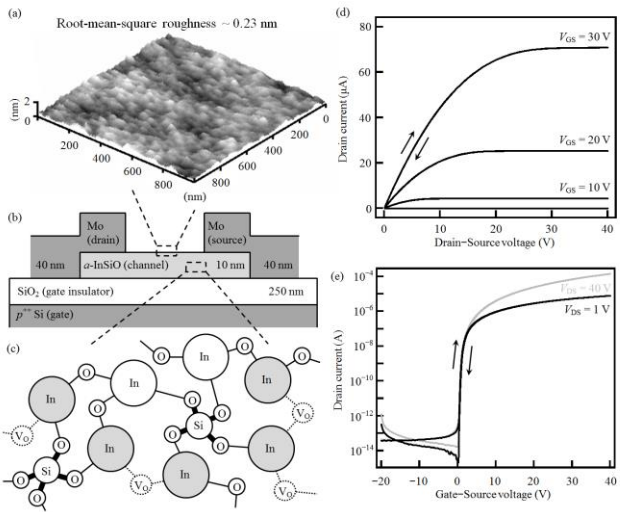

Fig.1. (a) Atomic force microscopy image of the surface of a-InSiO10 (InOx containing 10 wt.% SiO_2), showing a root-mean-squared roughness of ~0.23 nm. (b) Cross-sectional diagram of the SiM-OxTFT; the channel length and width were 350 and 1000 μm, respectively. (c) Schematic of VO suppression in a SiM-OxTFT channel. The white circles denote atoms with empty conduction bands (insulators), while the gray circles denote atoms with partially occupied conduction bands (conductors). (d) Output and (e) transfer curves of the a-InSiO10 TFT. The two transfer curves were extracted from the linear and saturation regions, respectively.

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