Influences of Annealing Conditions on Characteristics of Sn-doped Zinc Oxide Thin Film Transistors Fabricated by Atomic Layer Deposition

Tao Wang, Hong-Liang Lu*, Jian-Guo Yang, Wen-Jun Liu,

Shi-Jin Ding, and David Wei Zhang

State Key Laboratory of ASIC and System, Shanghai Institute of Intelligent Electronics & Systems, School of Microelectronics, Fudan University, Shanghai 200433

*honglianglu@fudan.edu.cn

Transparent oxide semiconductors employing a tin-doped zinc oxide (TZO) thin film generated via atomic layer deposition (ALD) at low temperature (150°C) are investigated for their feasibility into high performance thin film transistor (TFT). The resistivity of the as-deposited uniform TZO film is as low as $1.9\times10^{-2}\Omega$ cm. The carrier concentration is high up to $4.9\times10^{19}cm^{-3}$ and the optical transparency is greater than 80% in visible range. The TZO thin film transistors exhibit excellent electrical and optical properties. In addition, the insights into the dependency of the impurities within the channel layer upon thermal annealing of the oxide film are presented. Studies towards an optimized annealing temperature (300°C) result in a high device performance in enhancement mode with a field effect mobility (μ_{FE}) of $13.7cm^2/Vs$ and a subthreshold swing (S.S.) of 0.15V/dec. The performance of the TZO TFTs relies on carriers and defects in SnZnO and near the back-channel surface of SnZnO as well as the quality of the gate dielectric/SnZnO interface. Compared with the pristine devices, the TFT performance turned out to be dependent on the annealing temperature because of growing grain size and decreasing interface defects.

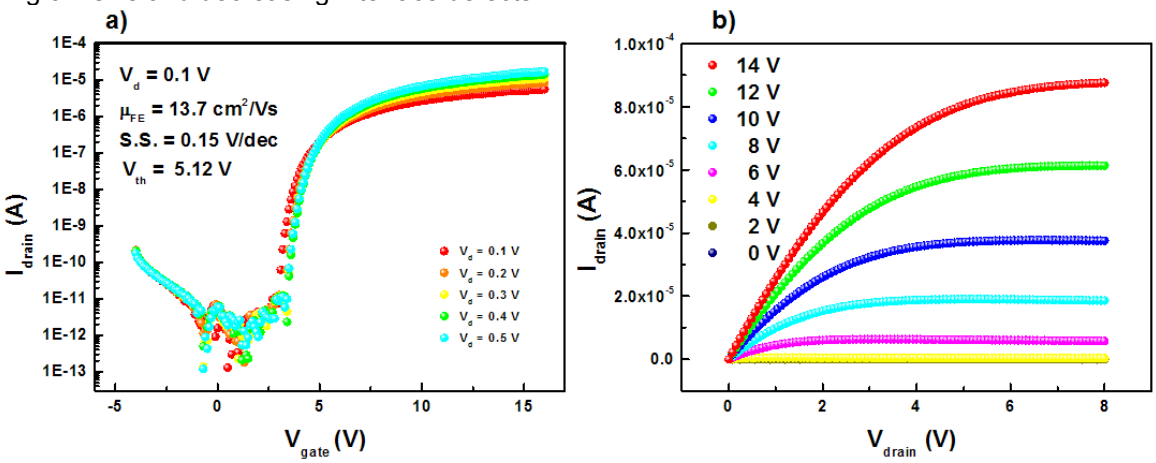

Figure (a) Transfer characteristics of SnZnO TFTs. (b) Output characteristics of SnZnO TFTs.

These findings on the influence of annealing conditions allow for a better understanding on the formation of the active semiconductor channel and serve towards the applicability of ALD based transparent oxide semiconductors in next generation electronics.