

Supporting Information

Effects of Li Doping on the Negative Bias Stress Stability of Solution-processed ZnO Thin Film Transistors

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Experimental Section

1. Preparation of pristine ZnO/Li doped ZnO semiconductor films

We dissolved 0.1626 g of zinc oxide powder (ZnO, >99%, Junsei) in 24 ml ammonia solution (NH₃, 25%, Wako pure chemical). To enhance the solubility of ZnO powder, the precursor solution was kept in a freezer for a day because ZnO particles easily precipitated in the precursor solution at room temperature. To Li doping, an aqueous lithium hydroxide solution is prepared by dissolving 0.2395 g (LiOH, 99.95 %, Sigma Aldrich) in 10 ml de-ionized water. Then, 0.2 ml of the aqueous lithium hydroxide solution was added to the 24 ml ZnO precursor solution. Subsequently, the Li doped ZnO precursor solution was spin coated at 3000 rpm for 30 s onto a SiO₂ (thermally grown on P⁺⁺-Si, thickness = 200 nm) wafer.

Depositing the ZnO film was performed by the same spin coating condition of the Li doped ZnO film using the ZnO precursor solution. Before spin coating, the wafer was cleaned with acetone and isopropyl alcohol (IPA). The spin coated film was annealed at 300 °C on a hotplate at ambient atmosphere for 1 hour.

2. TFT fabrication and electrical characterization.

To fabricate a bottom gate top contact structure of TFT, aluminum (Al) source/drain electrodes (thickness = 100 nm) were deposited on the ZnO layer with a shadow mask using a thermal evaporator. The width and length of channel are 1000 μm and 50 μm, respectively. Current-voltage characteristics were measured under vacuum using Agilent 4155B semiconductor parameter analyzer and vacuum chamber (M5V, MS Tech).

3. ZnO crystal structure characterization.

The crystal structure of ZnO and Li doped ZnO film were examined by high-resolution transmission electron microscope (HR-TEM, JEM-2100F, JEOL) and X-ray diffraction (New D8 Advance, Bruker).

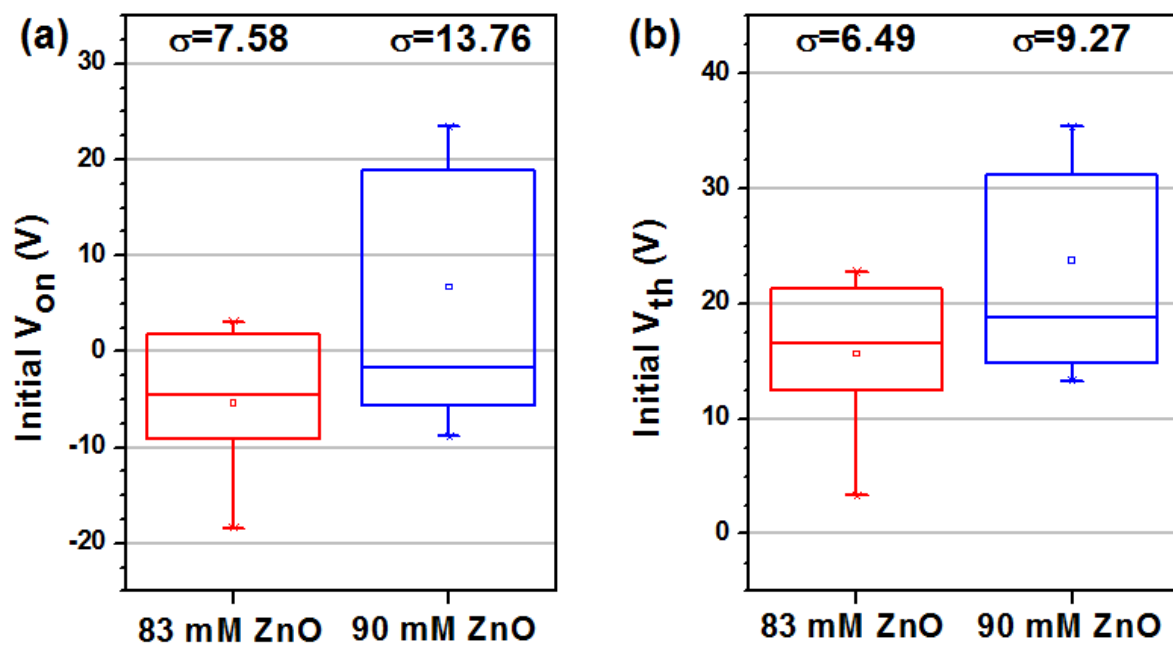


Figure S1. The box charts of the initial V_{on} and V_{th} of the ZnO TFTs from 80 mM and 90 mM zinc ammine complex solution.

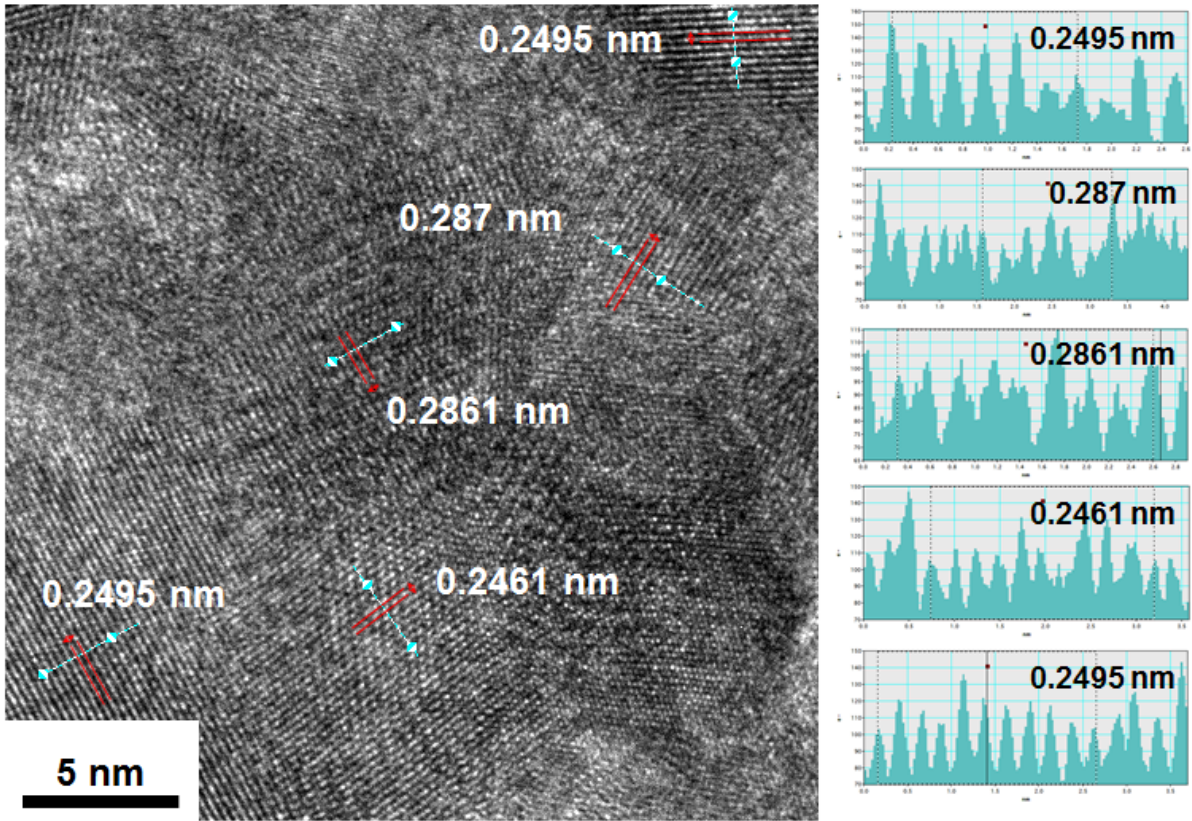


Figure S2. The top view image of HRTEM of the Li (20 mol%) doped ZnO film.

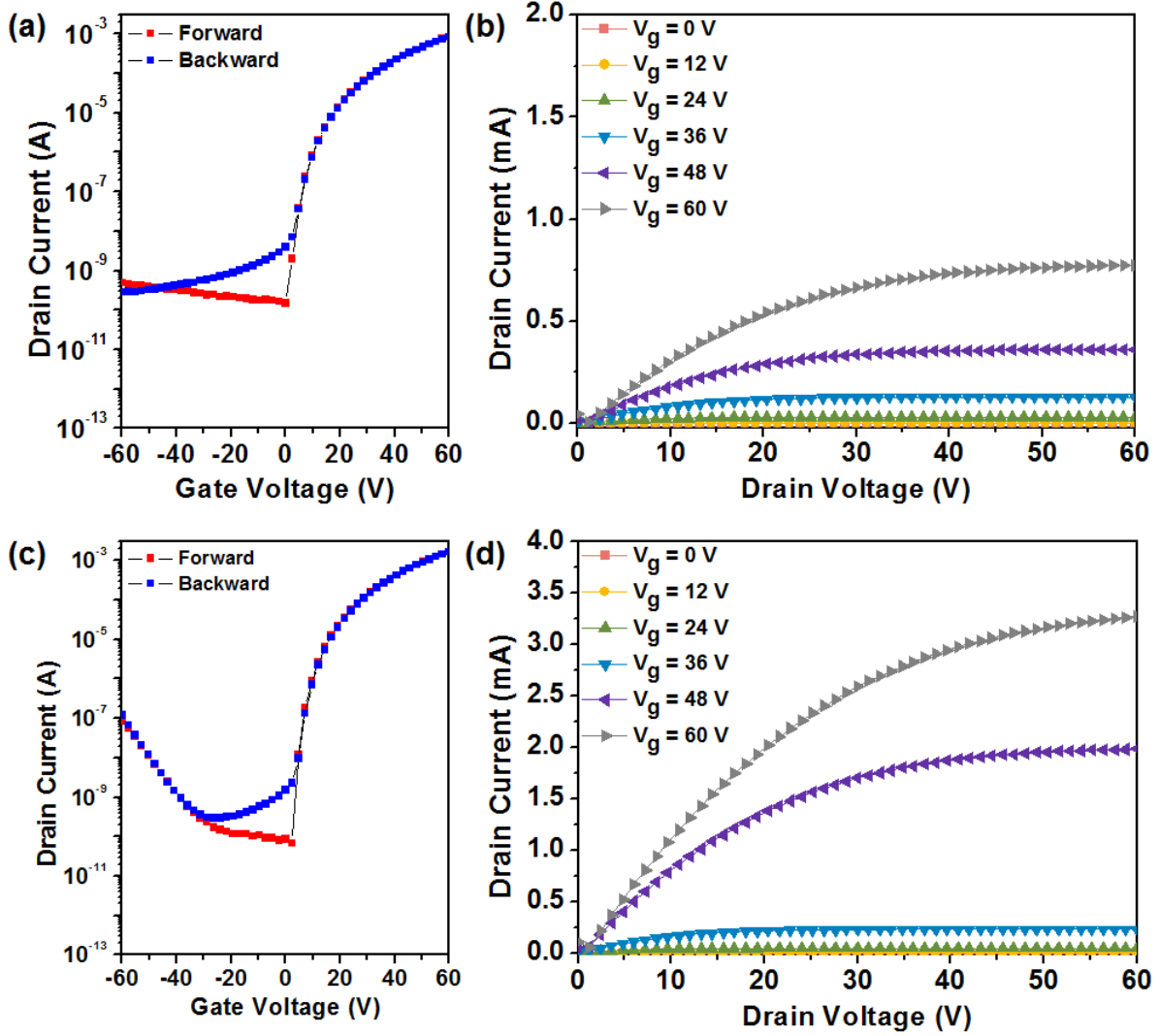


Figure S3. The output curves and hysteresis of pristine ZnO and Li (10 mol%) doped ZnO TFTs after NBS test. (a) and (b) Hysteresis and output curve of the pristine ZnO TFT after NBS, respectively. (c) and (d) Hysteresis and output curve of the Li doped ZnO TFT after NBS, respectively.

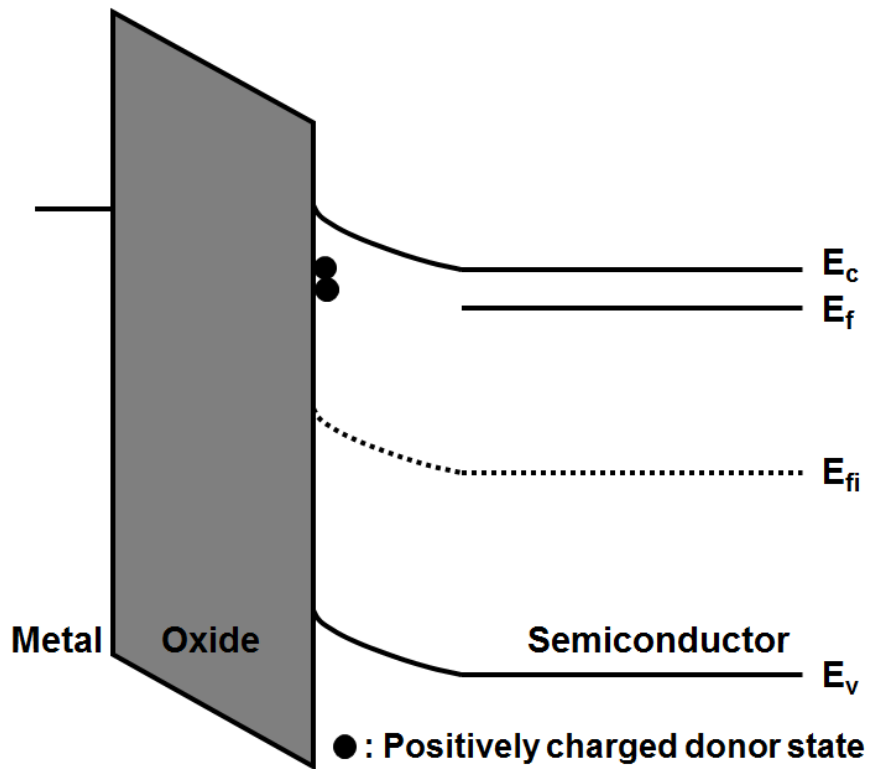


Figure S4. The illustration of the band bending diagram when the negative bias stress was applied.

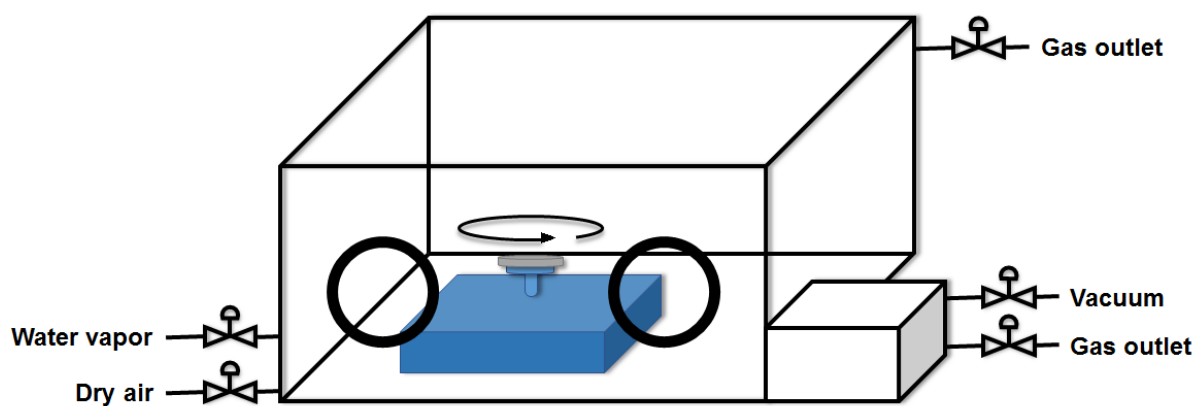


Figure S5. The schematic image of the glove box which is composed of feeding system of water vapor, dry air (approximately RH 7%), and gas outlet with humidity sensor.

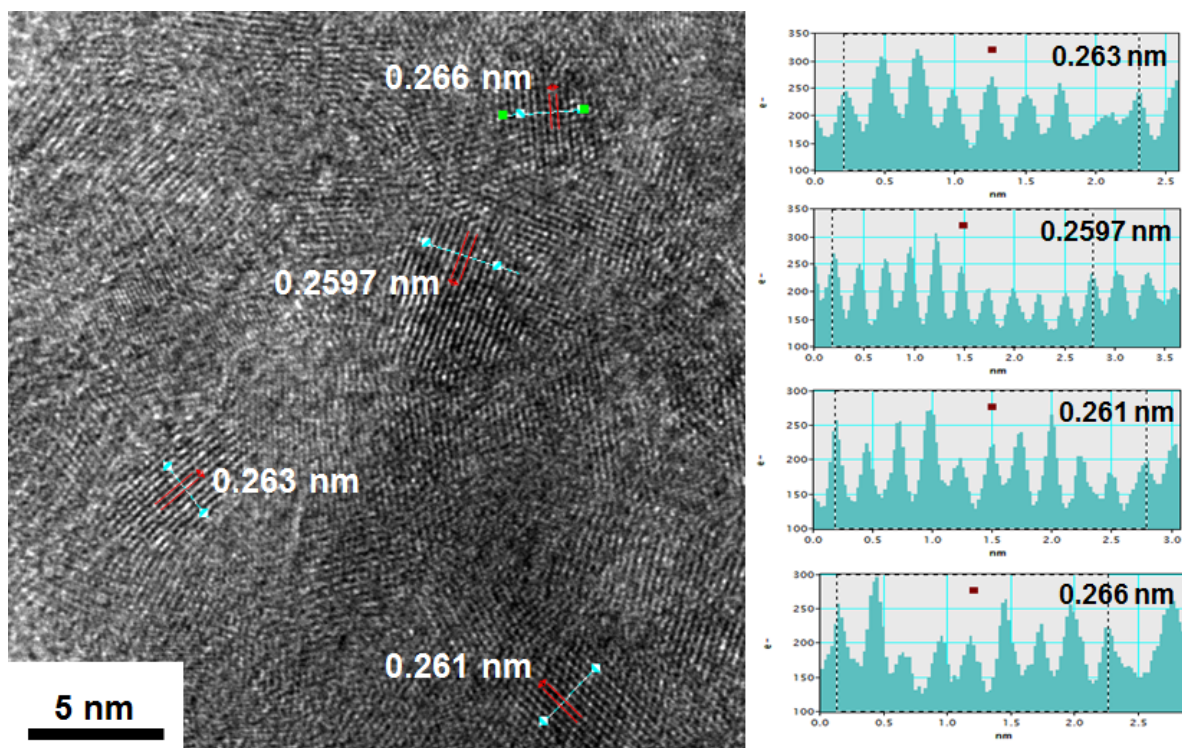


Figure S6. The top view image of HR-TEM of the pristine ZnO film.

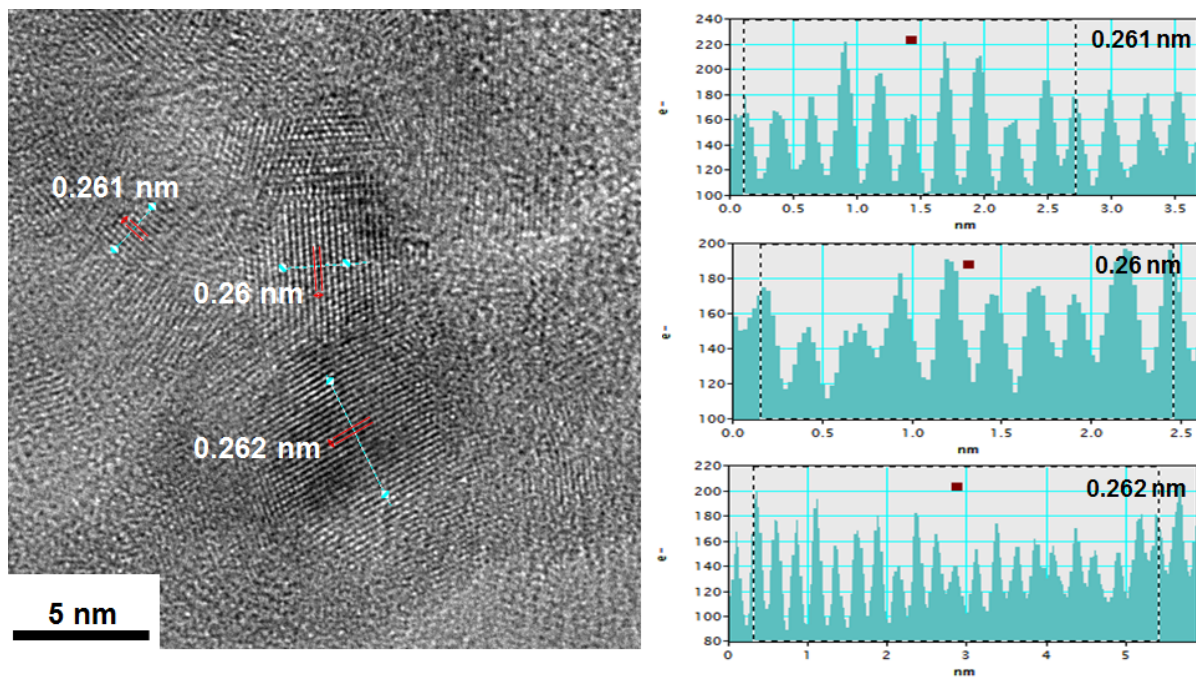


Figure S7. The top view image of HR-TEM of the Li (10 mol%) doped ZnO film.