Anion control as a strategy to achieve high-mobility and high-stability oxide thin-film transistors

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Supplementary Figures

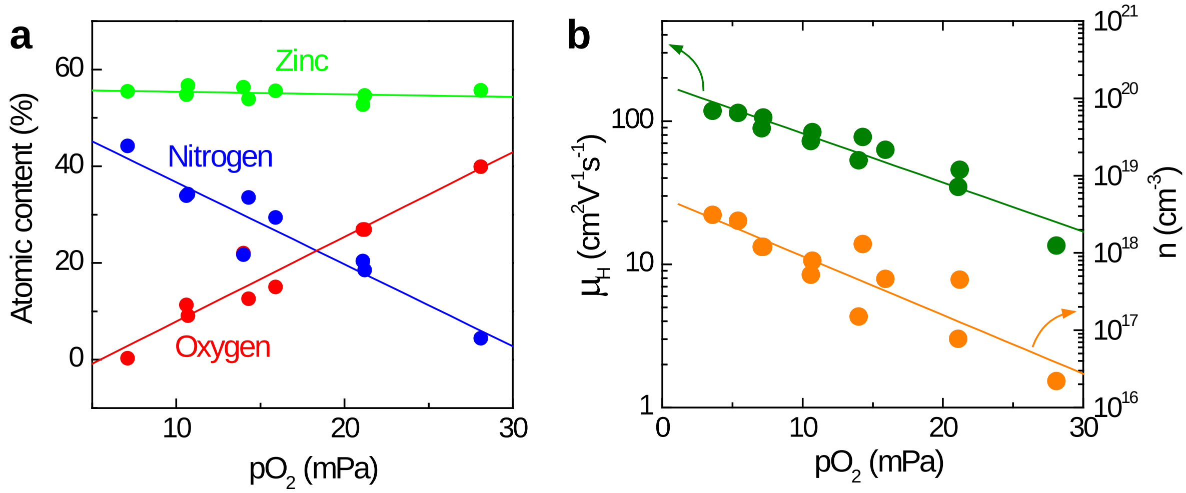

Figure S1. (a) Compositions of ZnON films determined by Rutherford backscattering spectroscopy (RBS) measurements, as a function of oxygen partial pressure. (b) The Hall mobility and carrier concentration of ZnON films deposited at different oxygen partial pressure.

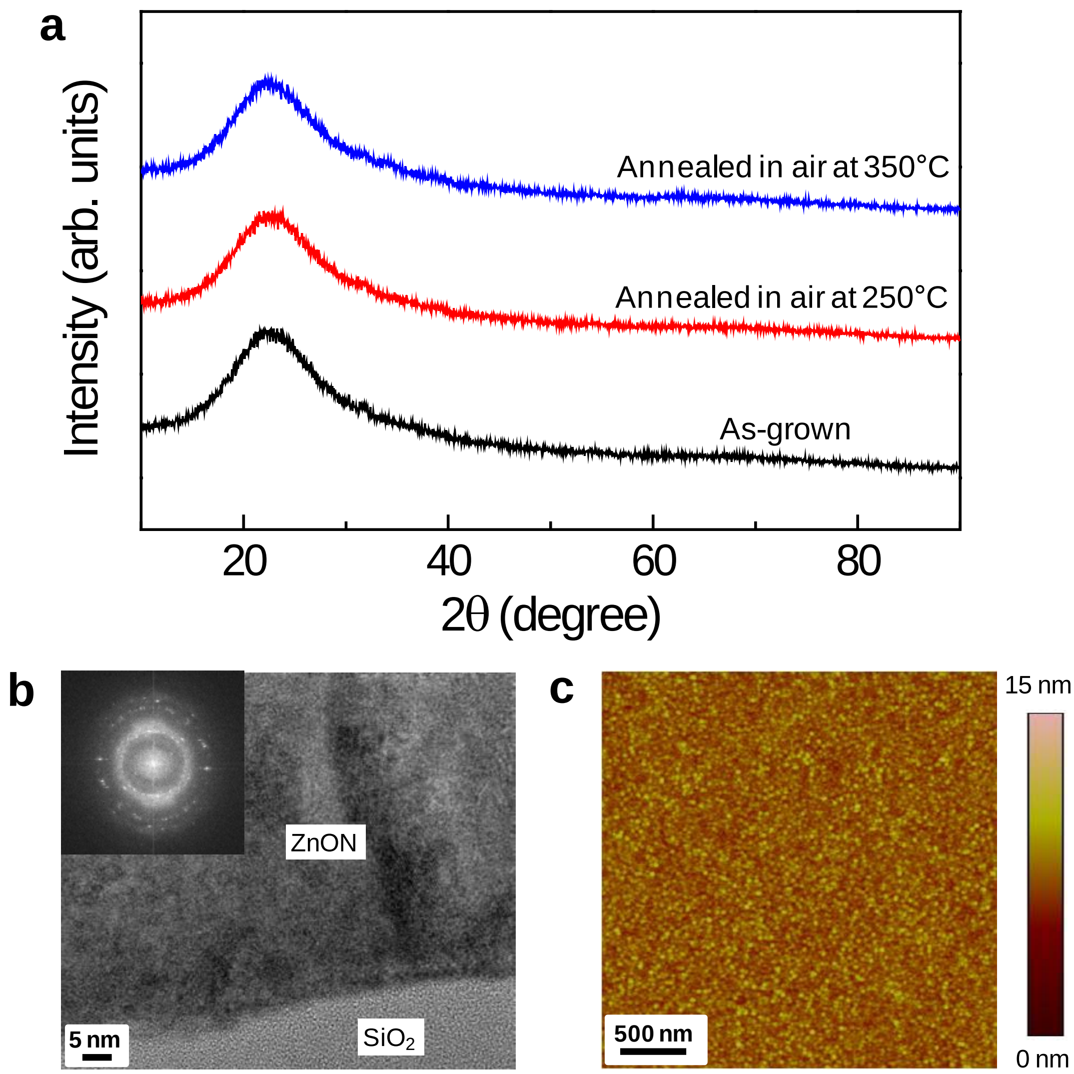

Figure S2. (a) Grazing incidence angle X-ray diffraction (GIAXRD) patterns for ZnON films deposited on glass substrates. The films were annealed at 250 °C and 350 °C for 1 h in air. No sharp peak is observed indicating the presence of an amorphous-like structure. (b) A high-resolution cross-sectional TEM image of amorphous-like ZnON film. Inset shows the fast Fourier transform (FFT) pattern acquired from the ZnON region. (c) A typical AFM image of ZnON film, where the scan size is 3 μm × 3 μm.

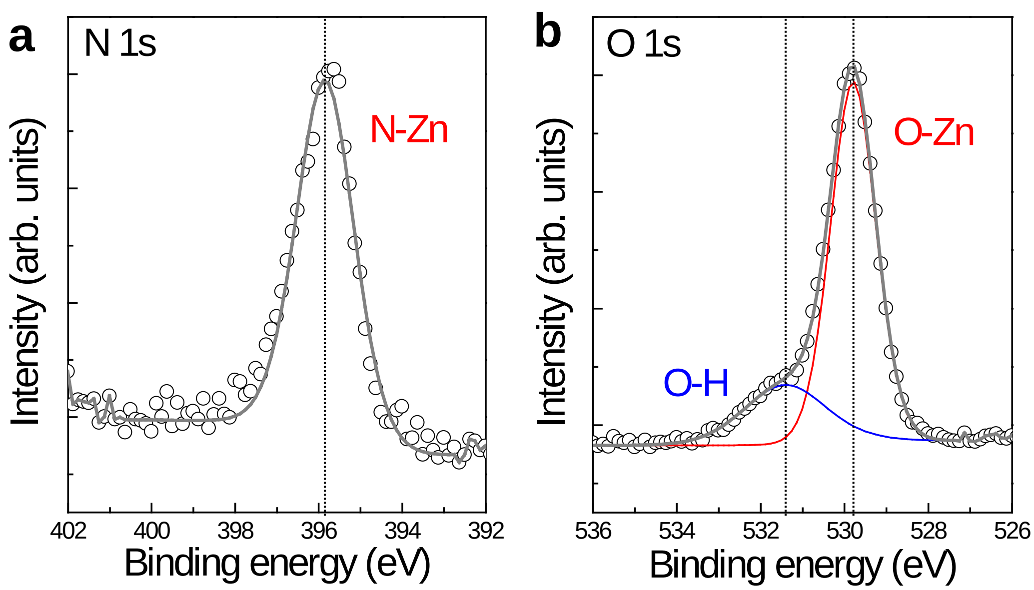

Figure S3. X-ray photoelectron spectroscopy (XPS) analysis of N 1s (a) and O 1s peak (b) for ZnON film.

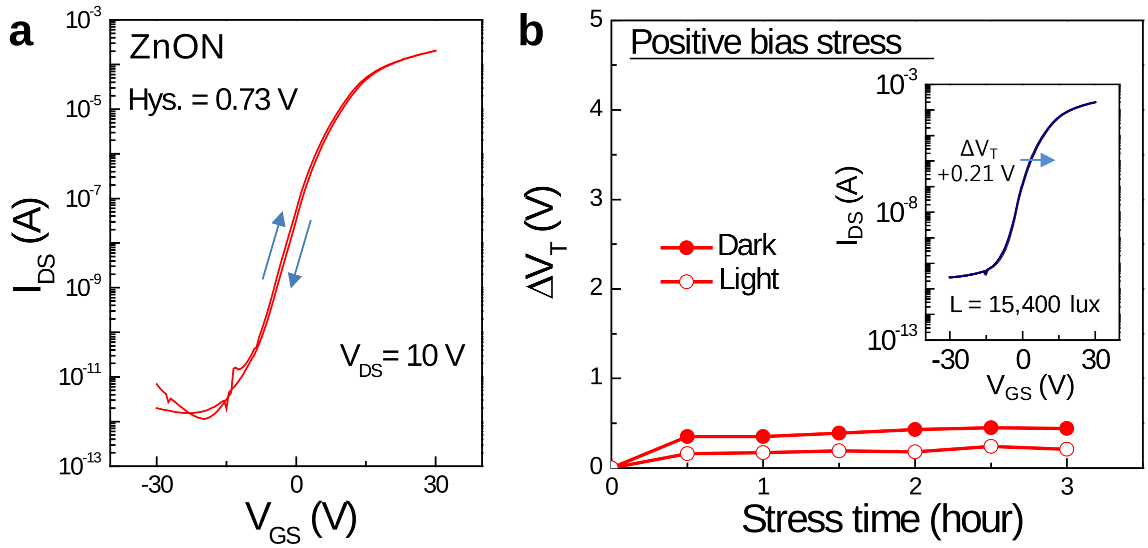

Figure S4. Typical hysteresis characteristics and positive bias stability of ZnON TFTs (a) The typical transfer characteristics for ZnON TFTs showing the hysteresis of 0.73 V between forward and reverse sweeps. The directions of the forward and reverse sweeps are indicated by the arrows. (b) ZnON TFTs under positive bias stress, where threshold voltage shift (ΔV_T) was measured as a function of stress time under dark and illumination (15,400 lux). The TFTs were stressed under V_{GS} = +20 V and V_{DS} = +0.1 V for 3 hours. Insets show the parallel positive shifts in the transfer characteristics of the TFT under illumination (15,400 lux). ZnON TFTs operate very stably without significant performance degradation under positive bias stress. It is also noted that the positive bias stability is not degraded under such a harsh illumination of 15,400 lux.

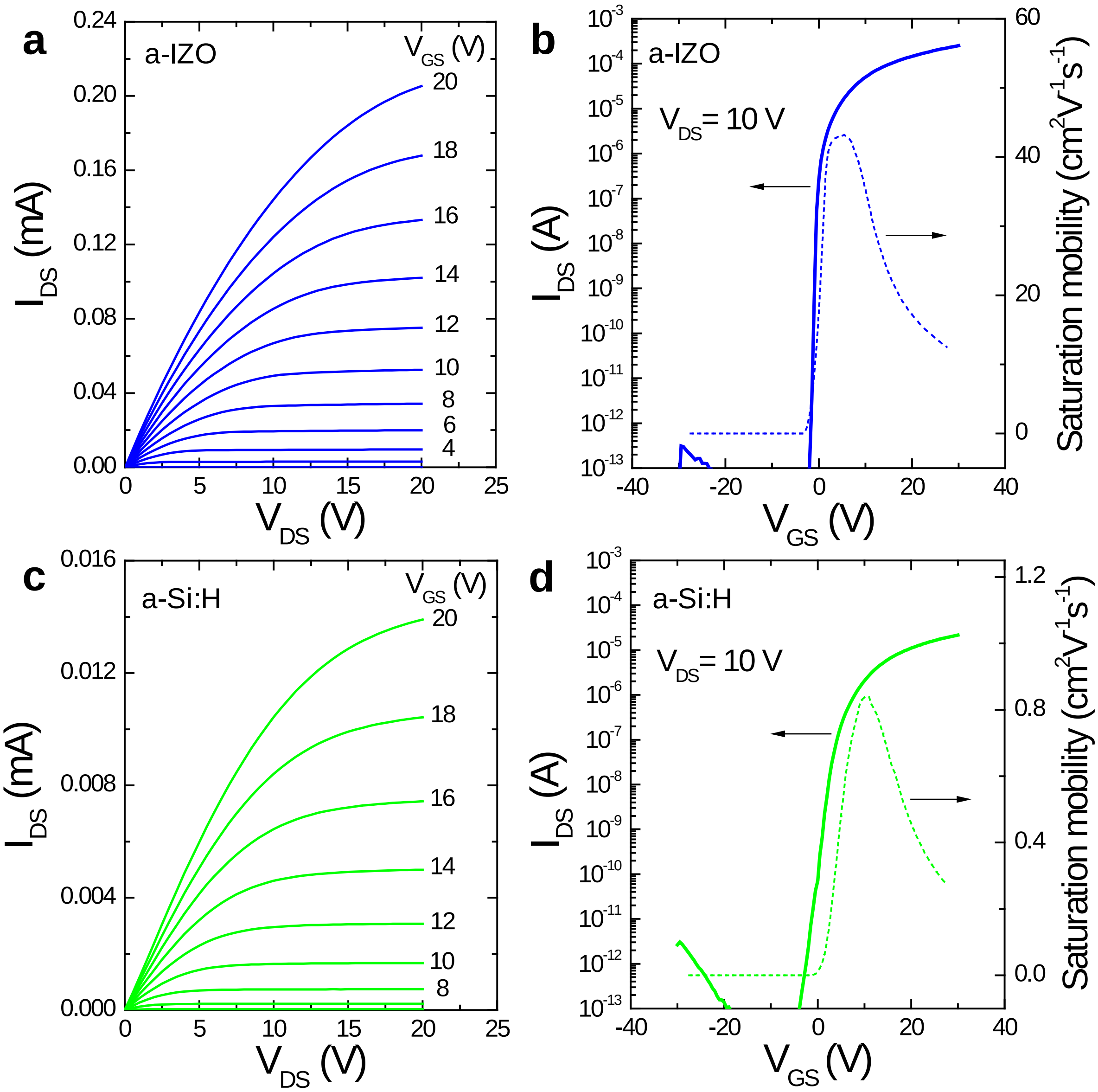

Figure S5. Typical TFT characteristics. (a) Output characteristics and (b) transfer curve for a-IZO TFTs. (c) Output characteristics and (d) transfer curve for a-Si:H TFTs.

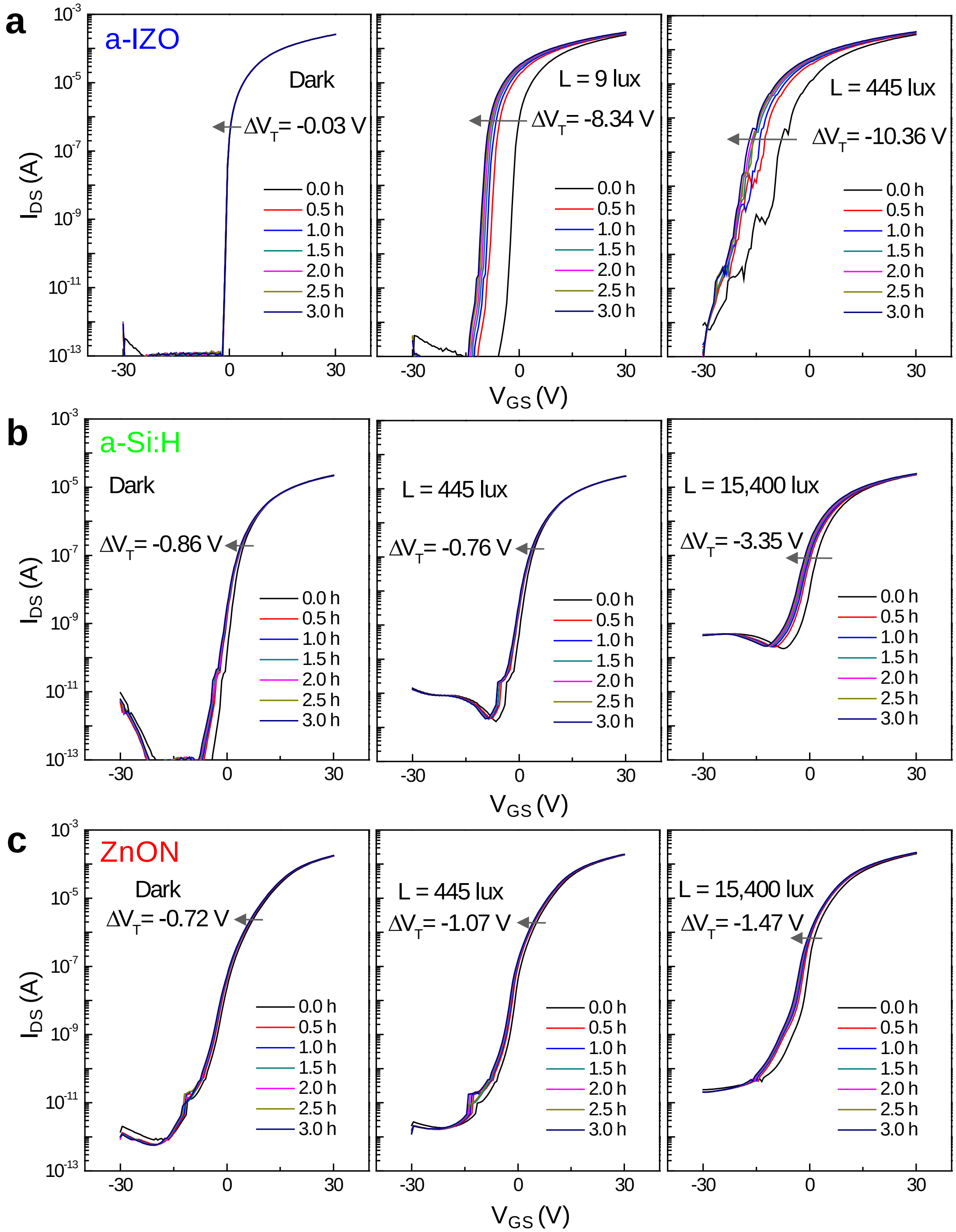

Figure S6. Evolution of the transfer curves as a function of the applied stress time without and with illumination of which the intensity is marked on the graph. (a) for a-IZO TFTs. (b) for a-Si:H TFTs. (c) for ZnON TFTs.

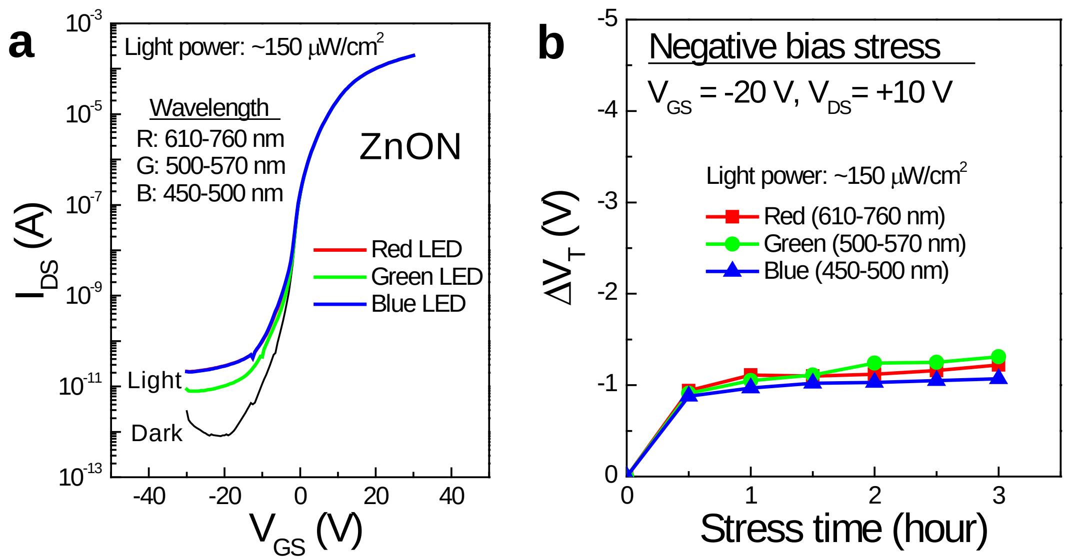

Figure S7. Wavelength dependence of ZnON TFT characteristics. (a) Transfer characteristics of the TFTs under exposure to red (wavelength: 610-760 nm), green (500-570 nm), and blue (450-500 nm) LEDs with a power of ~150 μW/cm^2. The TFTs are relatively less sensitive to green light region. (b) Threshold voltage shift (ΔV_T) as a function of time under exposure to various LEDs with different wavelength when the TFTs are subjected to negative gate bias stress (V_{GS} = -20 V and V_{DS} = +10 V for 3 hours). No noticeable difference in negative bias stability is found.