

## Supporting Information for:

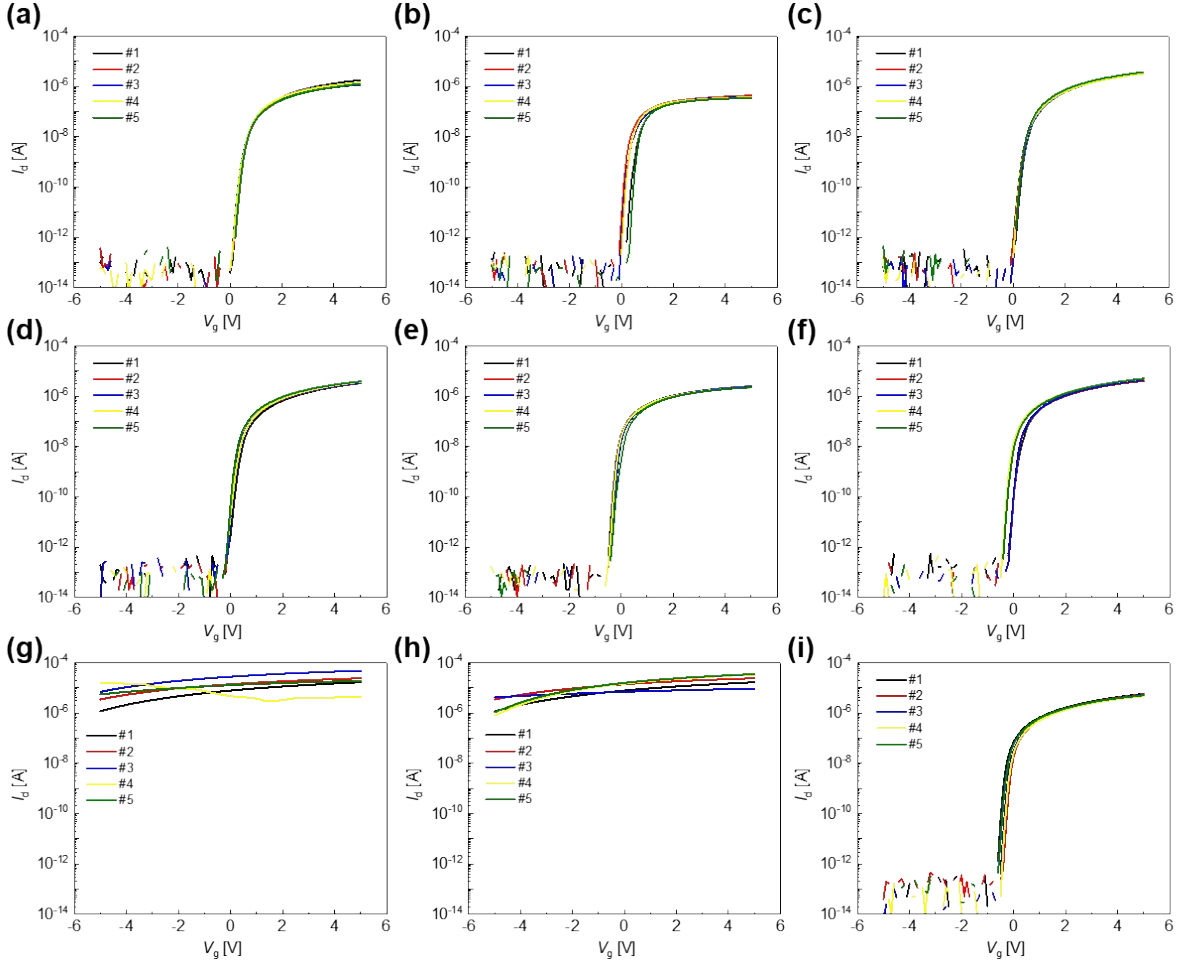
# Contact Properties of a Low-resistance Aluminum-based Electrode with Metal Capping Layers in Vertical Oxide Thin-film Transistors

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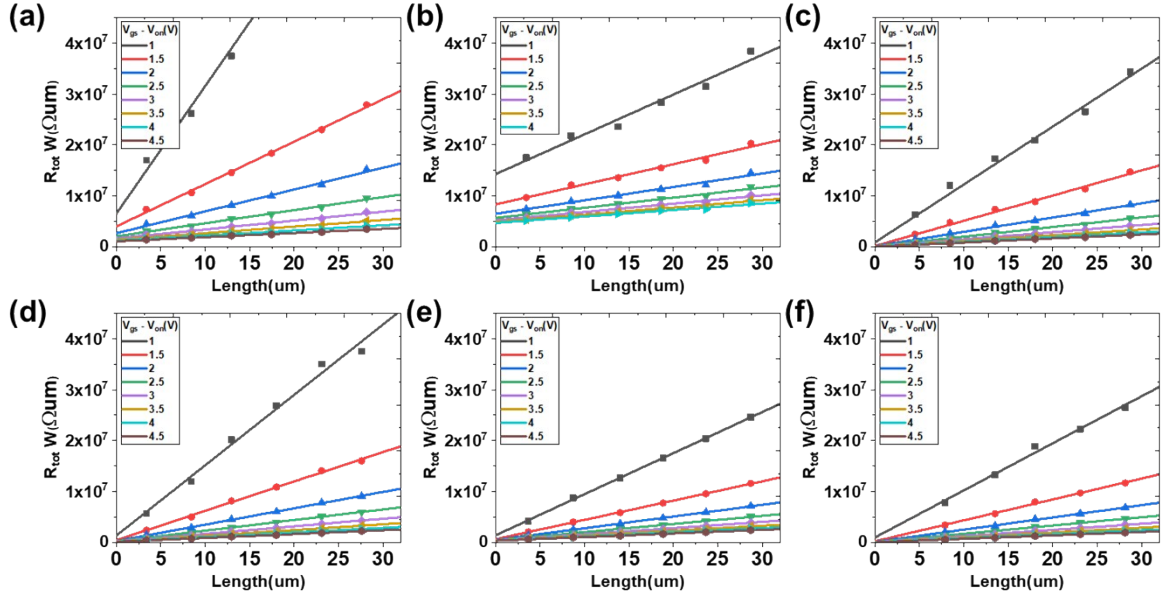
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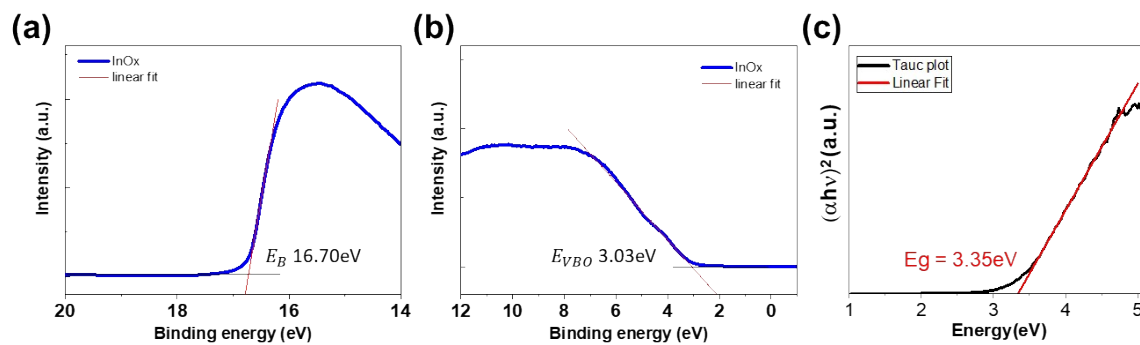
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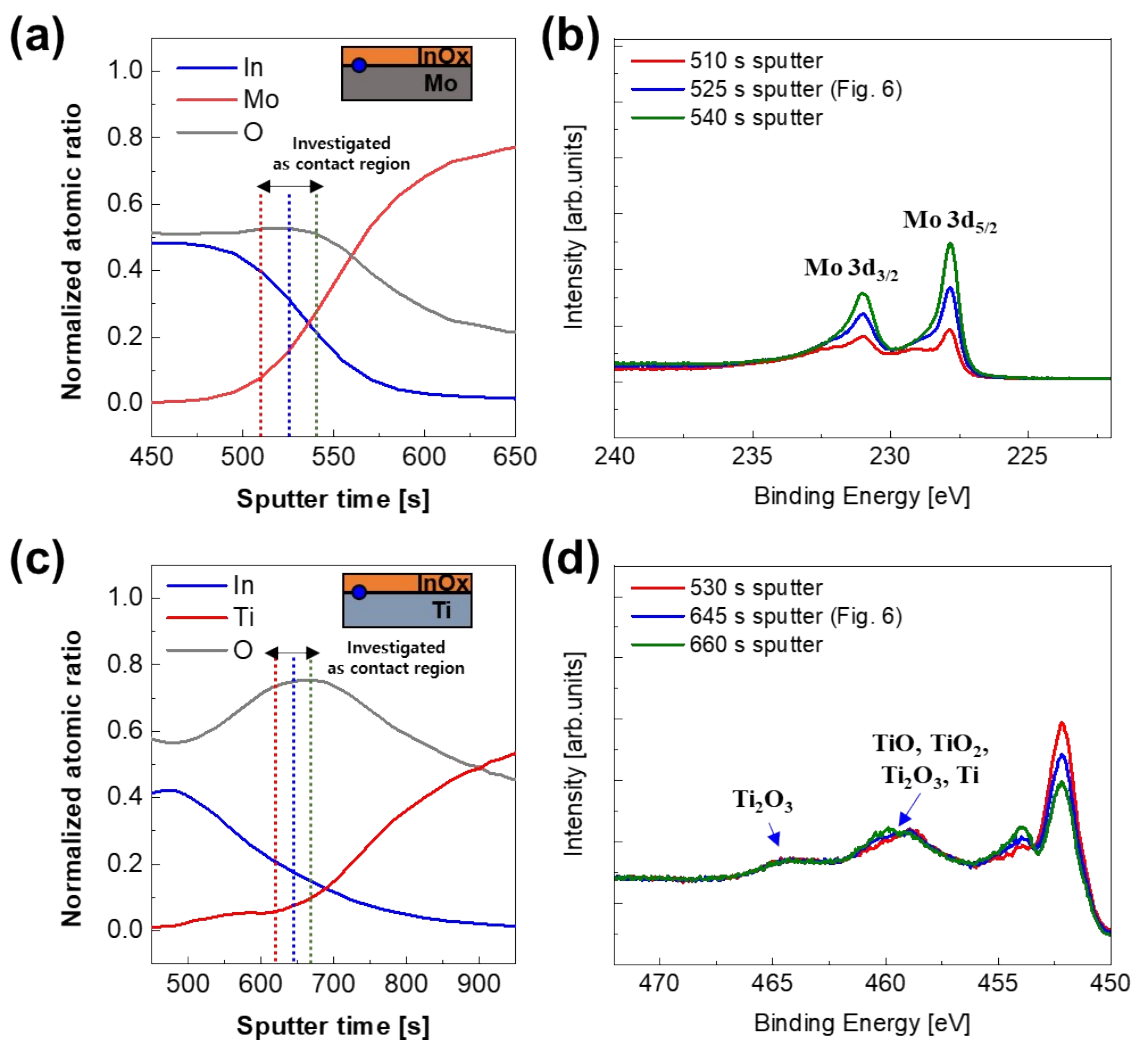
**Fig. S1.** Overlapped transfer curves of thin-film transistors (TFTs) with (a) Mo/Al/Mo, (b) Ti/Al/Ti, and (c) ITO source/drain (S/D) before annealing, (d) Mo/Al/Mo, (e) Ti/Al/Ti, and (f) ITO after annealing at 200 °C, and (g) Mo/Al/Mo, (h) Ti/Al/Ti, and (i) ITO S/D after annealing at 250 °C.



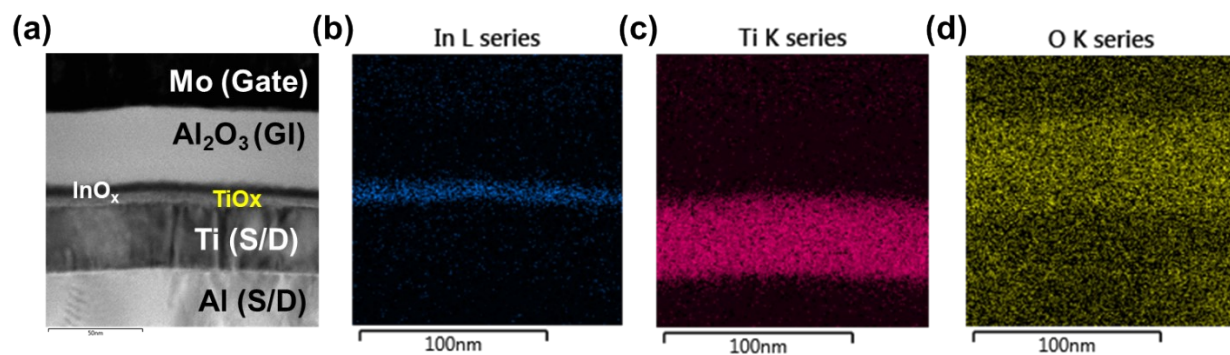
**Fig. S2.** Linear graphs of  $R_{tot} W$  versus the channel length ( $L$ ) in the top-gate bottom-contact (TGBC) thin-film transistors (TFTs) with (a) Mo/Al/Mo, (b) Ti/Al/Ti, and (c) ITO electrodes before annealing. The same relationship of the devices with (a) Mo/Al/Mo, (b) Ti/Al/Ti, and (c) ITO after annealing at 200 °C.



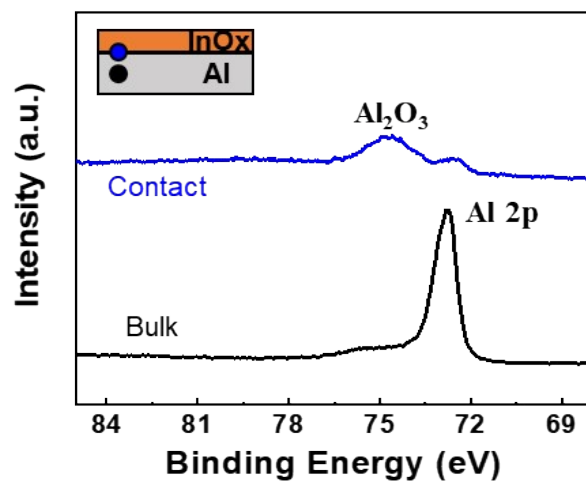
**Fig. S3.** Ultraviolet photoelectron spectroscopy (UPS) spectra of InO<sub>x</sub> at (a) higher binding energy edge of secondary electrons and (b) valence band edge region. (c) Tauc plot of InO<sub>x</sub> based on the transmission spectra to calculate the band gap.



**Fig. S4.** X-ray photoelectron spectroscopy (XPS) depth profile for film stacks with (a) Mo and (c) Ti electrode. XPS spectra of metal peaks of (b) Mo 3d and (d) Ti 2p in approximate contact regions according to the sputtering times.



**Fig. S5.** (a) Cross-sectional high-resolution transmission electron microscopy (TEM) images of film stacks with Ti electrodes. The energy dispersive spectroscopy (EDS) mappings of (b) In, (c) Ti, and (d) O elements.



**Fig. S5.** X-ray photoelectron spectroscopy (XPS) spectra of Al peaks in the Al bulk metal region (black line) and contact region (blue line) with  $\text{InO}_x$ .