

Supporting Information

High-Performance Flexible Oxide TFTs: Optimization of a-IGZO Film by Modulating Voltage Waveform of Pulse DC Magnetron Sputtering without Post Treatments

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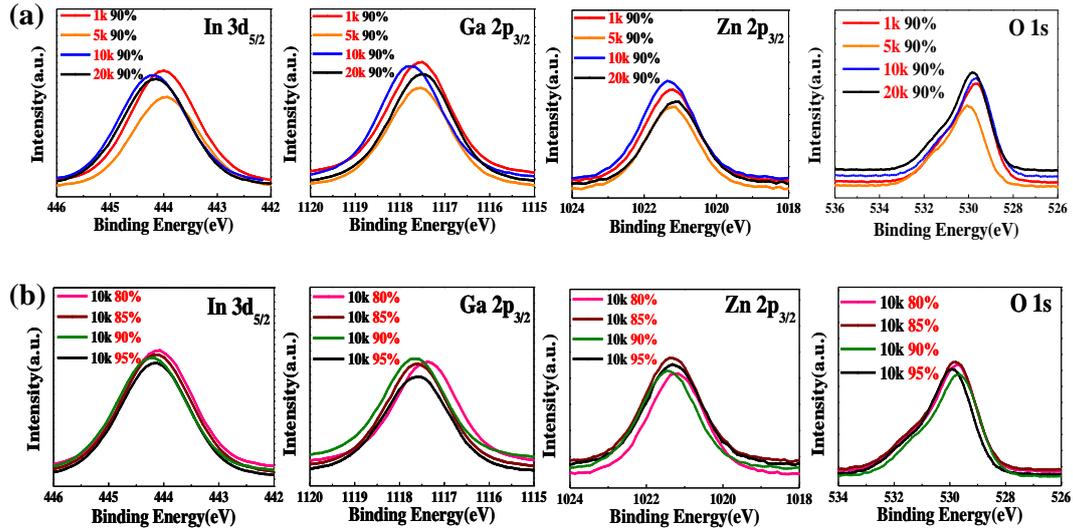


Figure.S1 The In 3d_{5/2}, Ga 2p_{3/2}, Zn 2p_{3/2} and O 1s core level XPS spectra for 50 nm-thick IGZO films sputtered by the modulated waveform with varying (a) frequency and (b) duty cycles

Table.S1 The electrical properties of a-IGZO TFTs and the corresponding IGZO films' density.

Frequency/ Duty Cycle	Mobility (cm ² V ⁻¹ s ⁻¹)	I _{on} /I _{off}	SS (V dec ⁻¹)	V _{on} (V)	Density (g/cm ³)
1kHz/80%	1.2	1.1x10 ⁶	0.70	9.1	5.80
1kHz/85%	2.4	7.9x10 ⁶	0.67	5.4	5.92
1kHz/90%	5.6	2.5x10 ⁷	0.51	3.5	5.99
1kHz/95%	15.9	9.8x10 ⁷	0.61	-0.3	6.12
5kHz/80%	3.5	9.5x10 ⁶	0.49	9.3	5.88
5kHz/85%	3.3	6.7x10 ⁶	0.53	9.6	5.92
5kHz/90%	8.3	8.1x10 ⁷	0.42	5.4	5.96
5kHz/95%	18.1	1.1x10 ⁸	0.38	1.5	6.17
10kHz/80%	13.3	2.1x10 ⁸	0.48	0.7	6.06
10kHz/85%	11.3	1.3x10 ⁸	0.61	-2.9	6.08
10kHz/90%	25.8	4.1x10 ⁸	0.44	-2.6	6.17
10kHz/95%	3.9	9.7x10 ⁶	0.42	3.2	6.23
20kHz/80%	11.8	9.0x10 ⁶	0.88	3.9	6.05
20kHz/85%	13.5	1.5x10 ⁷	0.56	5.7	6.08
20kHz/90%	14.4	2.0x10 ⁷	0.79	4.1	6.20
20kHz/95%	12.8	2.2x10 ⁷	0.52	4.5	6.32

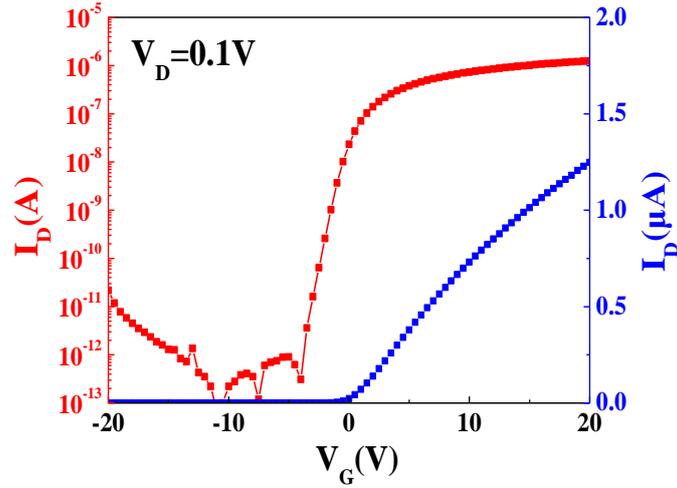


Figure.S2 The transfer characteristic curve with drain voltage of 0.1 V of the flexible IGZO TFT on PI substrate.

The transfer characteristic curve with drain voltage of 0.1 V of the flexible IGZO TFT on PI substrate fabricated by optimal conditions ($f=10$ kHz, $\gamma=90\%$) is shown in **Figure.S2**. The linear mobility (μ_{lin}) is extracted by the formula:

$$\mu_{lin} = \frac{\left(\frac{d I_D}{d V_G} \right)}{V_D C_i \left(\frac{W}{L} \right)}$$

where $C_i = 38$ nF/cm² and $W/L = 500/100$ μm μm^{-1} . The μ_{lin} of the flexible IGZO TFT with drain voltage of 0.1 V is 13.1 cm² V⁻¹ s⁻¹, which is lower than the μ_{sat} , (20.9 cm² V⁻¹ s⁻¹). It can be due to the existence of 3-nm-thick Al₂O₃ passivation layer between the electrodes and channel, which requires a certain voltage potential for an efficient tunneling effect to drive electrons to form high-flux current flow along the channel layer.