Electronic Supplementary Material (ESI) for Journal of Materials Chemistry

Electronic Supplementary Information

High performance and High Stability Low temperature Aqueous Solution-Derived Li-Zr Co-doped ZnO TFTs

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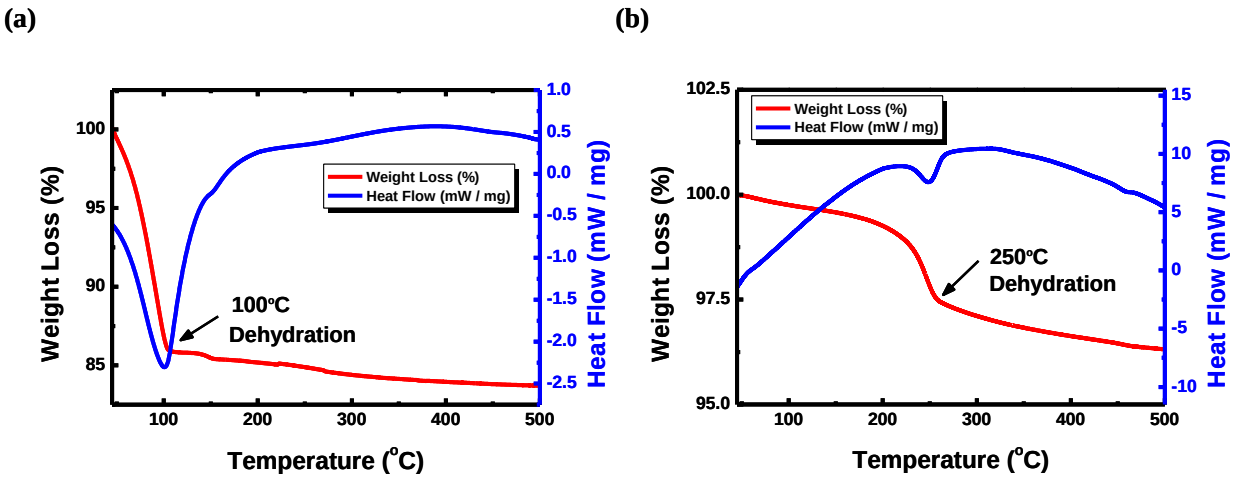


Figure S1. Thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) curves of used **(a)** $Zn(OH)_2$ and (b) $Zr(OH)_4$ precursor powder under air at a heating rate 5 °C/min.

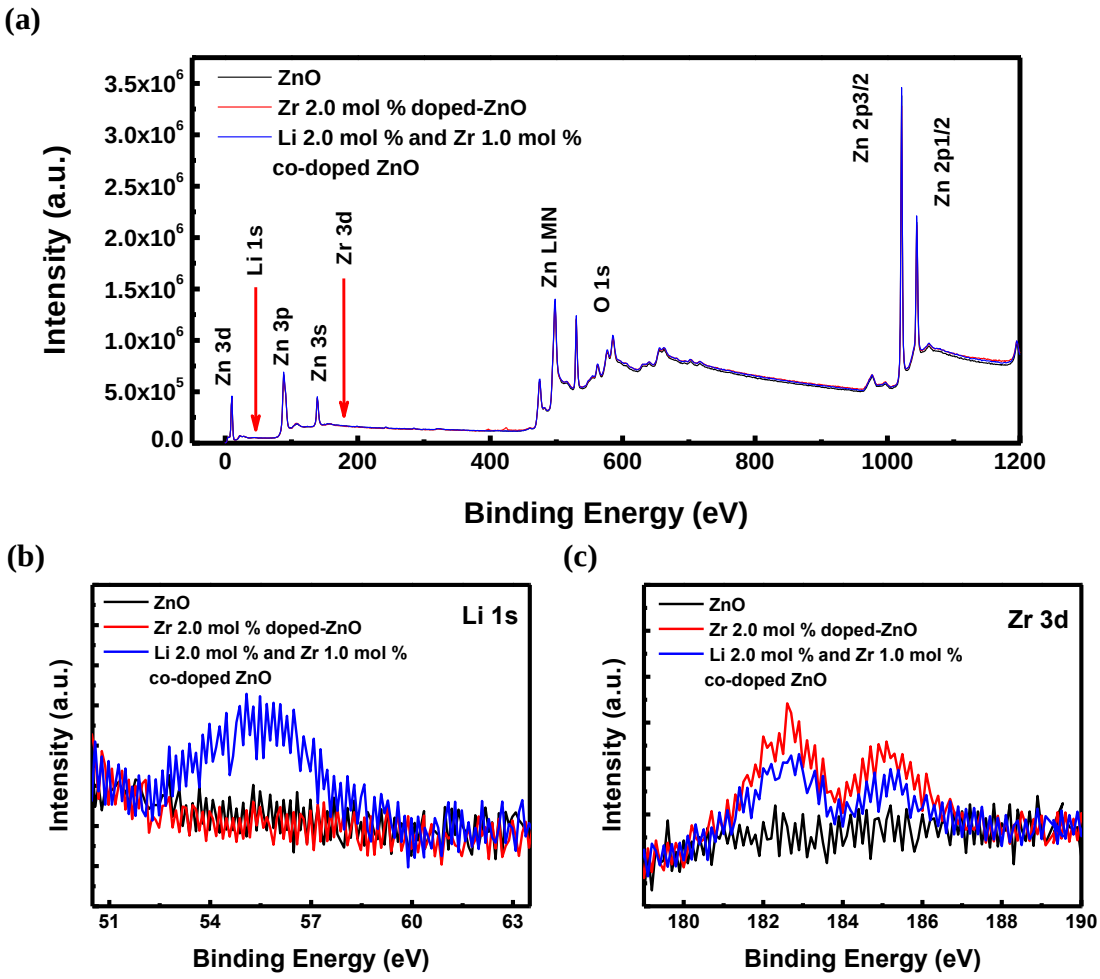
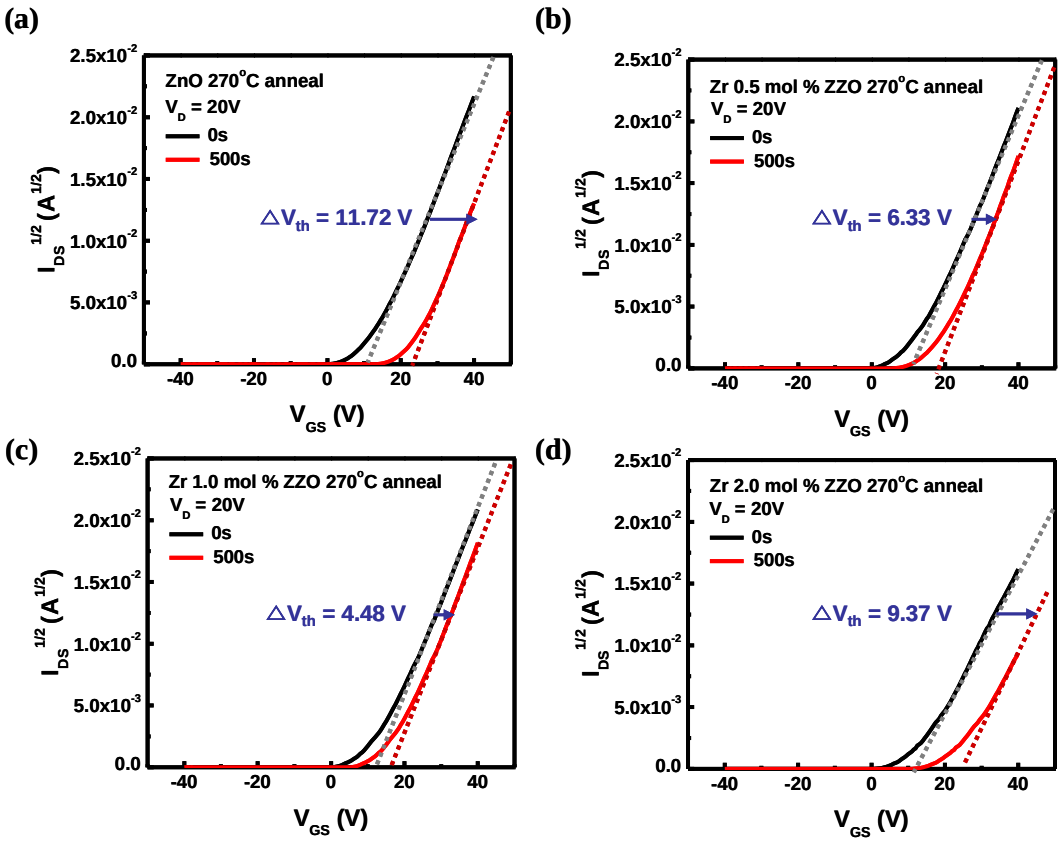
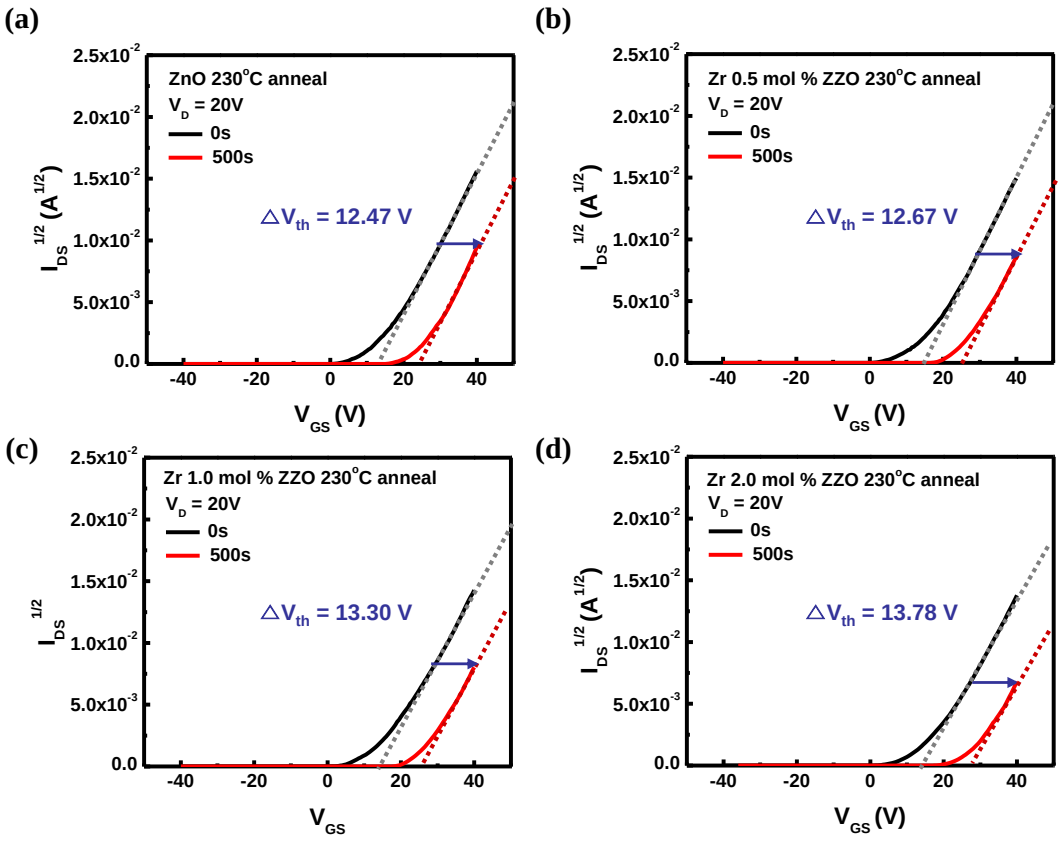


Figure S2. (a) Broad XPS scan spectra of ZnO, Zr 2.0 mol % doped-ZnO (2.0 mol % ZZO) and Li 2.0 mol %-Zr 1.0 mol % co-doped ZnO (2.0 mol % LZZO) thin films. The magnified XPS showing (b) Li 1s, (c) Zr 3d spectrum of ZnO, 2.0 mol % ZZO and 2.0 mol % LZZO thin film. The Zn 2p3/2 and Zn 2p1/2 binding energies of ZZO (Zr 2.0 mol % doped) and LZZO (Li 2.0 mol %-Zr 1.0 mol co-doped) are 1021.9 eV and 1044.9 eV, respectively. The peaks at 530 eV, 55.7 eV and 182.7 eV correspond to the binding energies of O1s, Li 1s and Zr 3d, respectively.



Zr doping content	Mobility ($cm^2V^{-1}s^{-1}$)	Threshold voltage (V)	ΔV_{th} (V)	Subthreshold value (V dec^{-1})	On/off current ratio
ZnO	1.59	6.97	12.72	1.19	7.22 x 10^7
Zr 0.5 mol % ZZO	1.52	6.23	6.33	0.98	3.46 x 10^7
Zr 1.0 mol % ZZO	1.47	6.82	4.48	0.92	3.39 x 10^7
Zr 2.0 mol % ZZO	1.07	7.63	9.37	1.07	2.74 x 10^7

Figure S3. $I_D^{1/2}$ vs. V_{GS} plots used to extract mobility, V_{th}, ΔV_{th}, SS value and on/off current ratio of solution-processed ZnO and Zr-doped ZnO TFTs annealed at 270 °C as a function of Zr contents after applying electrical stress with a gate bias of 20 V for 500 s (the line is a guide to the eye).



Zr doping content	Mobility / $cm^2V^{-1}s^{-1}$	Threshold voltage / V	ΔV_{th} / V	Subthreshold value / V dec^{-1}	On/off current ratio
ZnO	0.93	7.80	12.47	1.27	2.23 x 10^7
Zr 0.5 mol % ZZO	0.92	8.21	12.67	1.14	2.75 x 10^7
Zr 1.0 mol % ZZO	0.87	8.44	13.30	1.09	1.79 x 10^7
Zr 2.0 mol% ZZO	0.82	8.97	13.78	1.23	2.72 x 10^7

Figure S4. $I_D^{1/2}$ vs. V_{GS} plots used to extract mobility, V_{th}, ΔV_{th}, SS value and on/off current ratio of solution-processed ZnO and Zr-doped ZnO TFTs annealed at 220 °C as a function of Zr contents after applying electrical stress with a gate bias of 20 V for 500 s (the line is a guide to the eye).

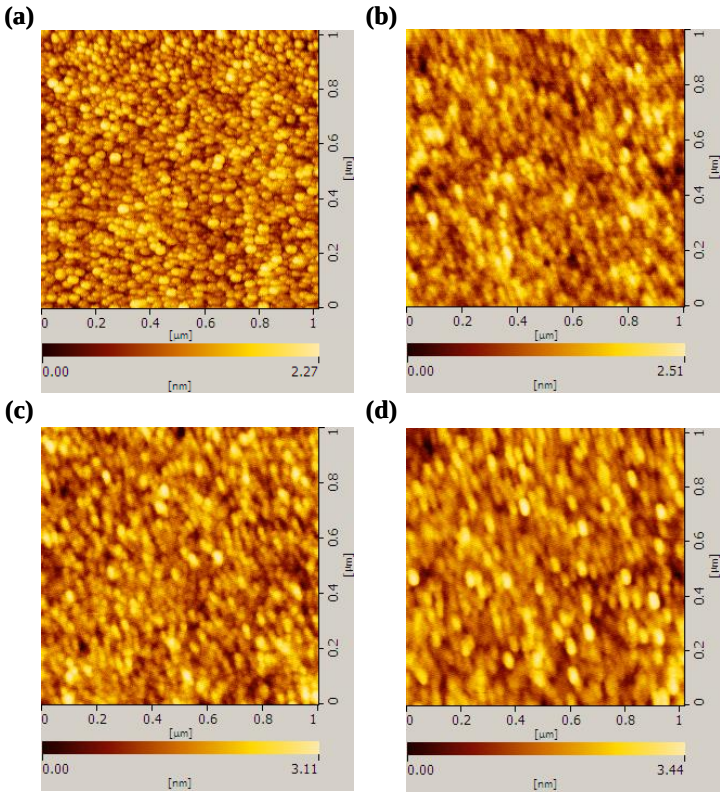


Figure S5. Representative two-dimensional AFM height images of (a) 0.0 mol % (b) 0.5 mol % (c) 1.0 mol % (d) 2.0 mol % Li doping in 1.0 mol % ZZO films.

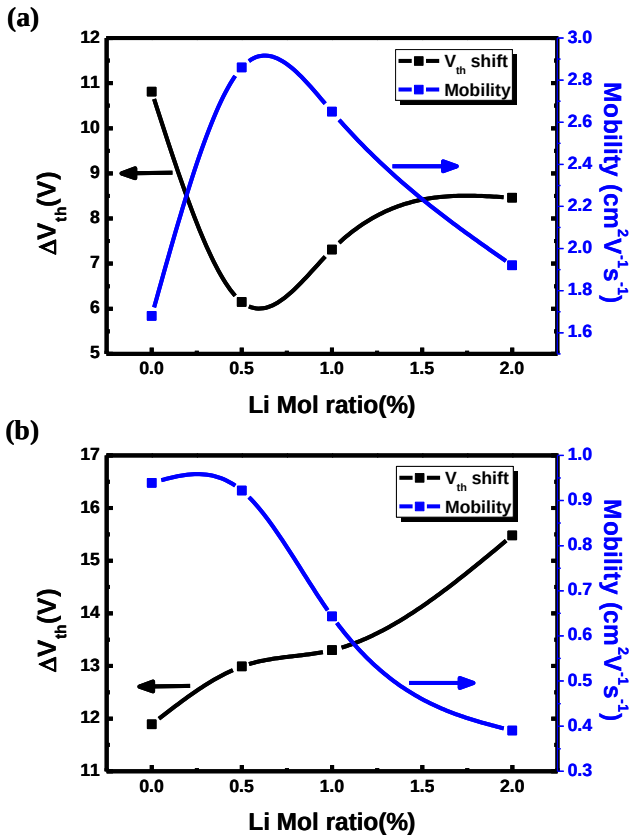


Figure S6. Variations in mobility and ΔV_{th} of solution-processed ZnO TFTs and Li-doped ZZO TFTs annealed at (a) 270 ^{o}C and (b) 220 ^{o}C as a function of Li contents.