Supporting Information for:

Influence of Al doping ratio on properties of ZnO:Al passivating contacts for crystalline silicon solar cells

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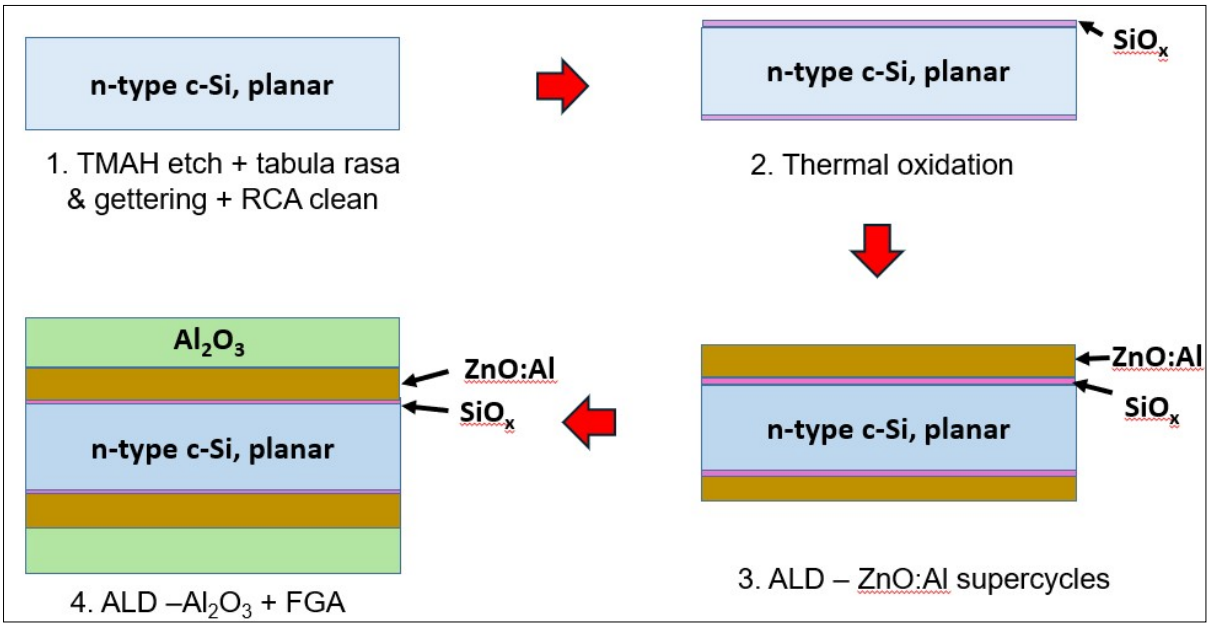

Figure S1: Schematic diagram of the fabrication process of a sample symmetrically passivated with a SiO_x/ZnO:Al/Al_2O_3 stack for the lifetime measurements.

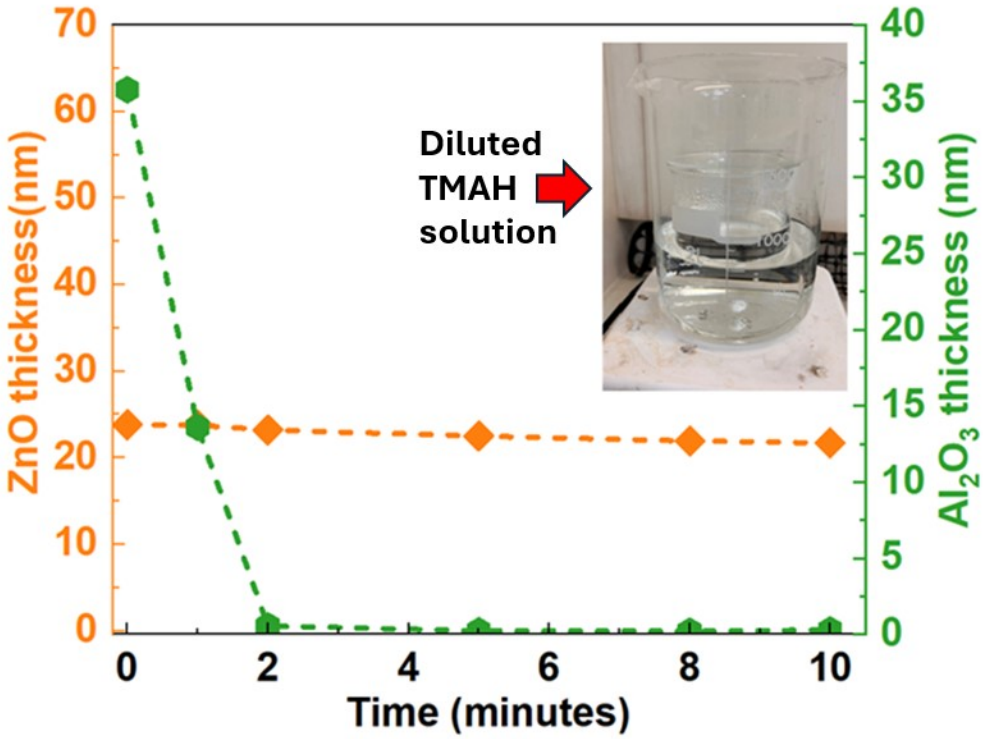

Figure S2: Thickness versus etching time of ZnO and Al_2O_3 in diluted TMAH solution at 60 °C.

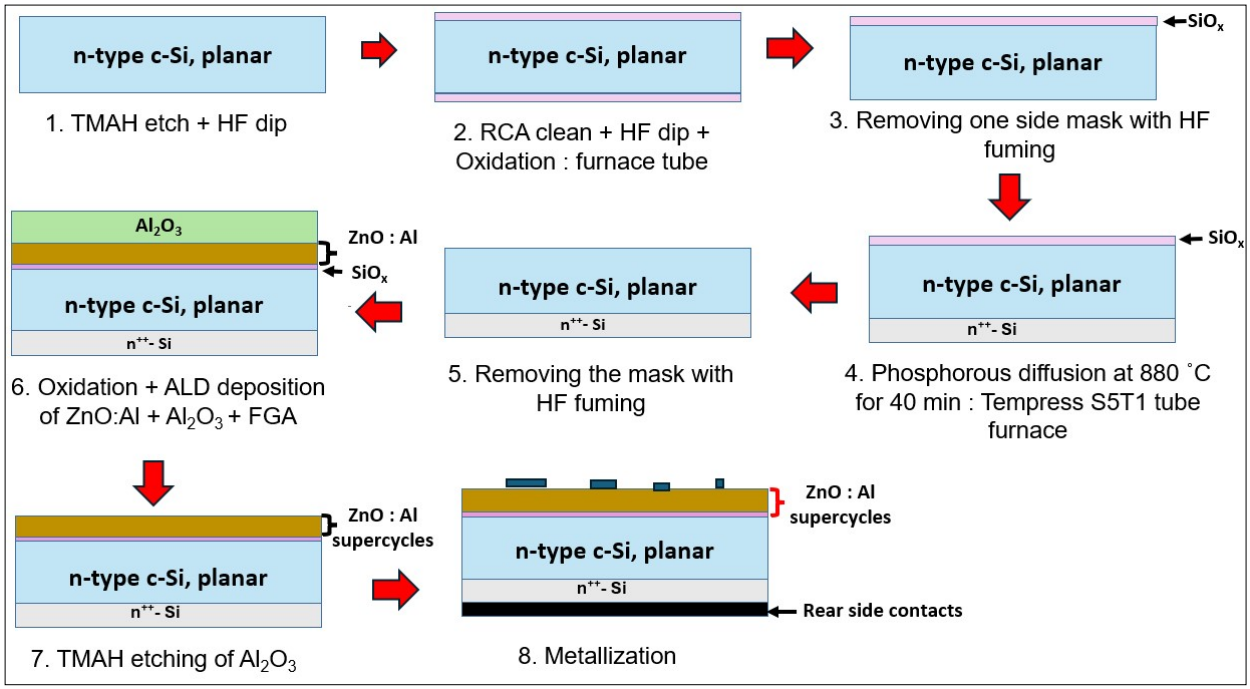

Figure S3: Schematic diagram of the fabrication process of the SiO_x/ZnO:Al stack on the front side of rear-side-diffused substrates for the contact resistivity measurements. After the etching of the Al_2O_3 capping layer, metal electrodes were evaporated using thermal evaporation through a shadow mask to form a Cox–Strack pattern (which consists of circles with diameters of 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.5, 0.6 and 0.7 mm).

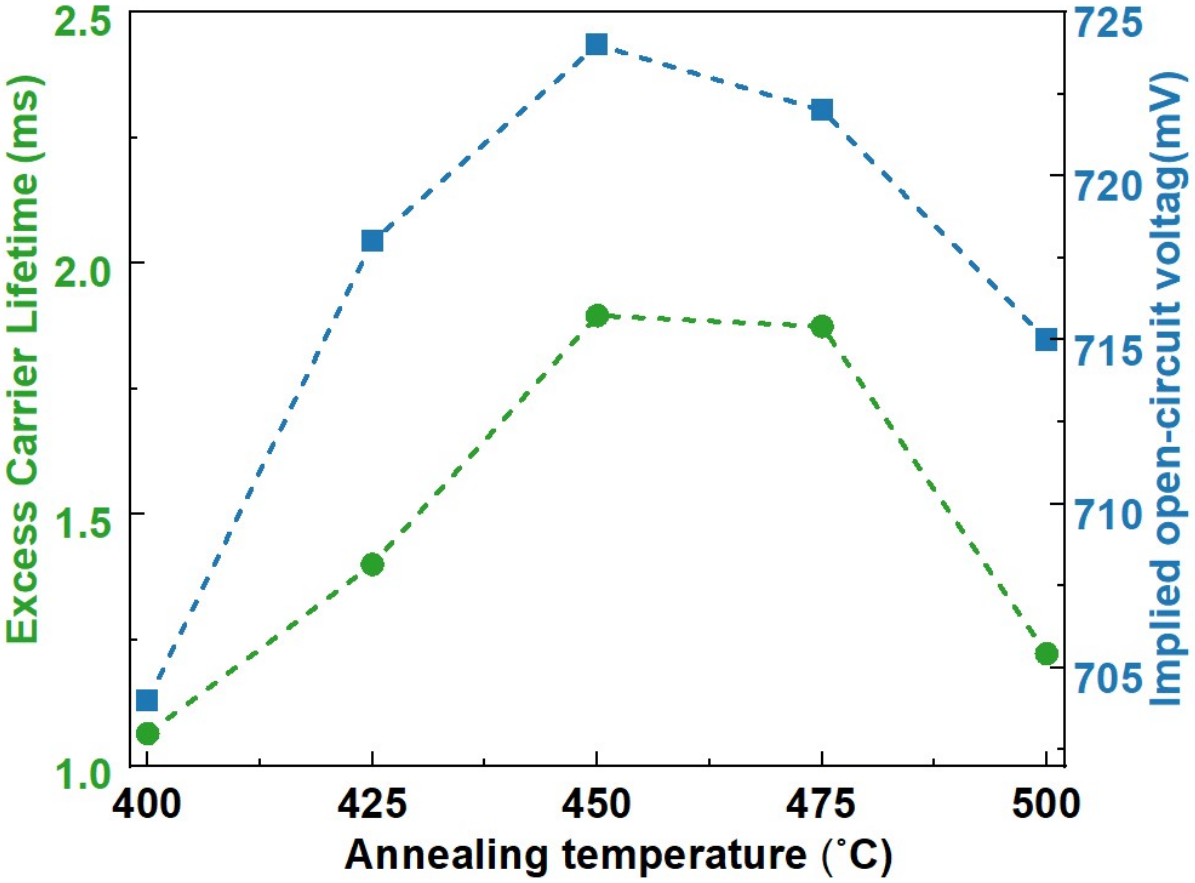

Figure S4: Implied V_{oc} and lifetime of c-Si wafers with symmetrical $SiO_x/ZnO/Al_2O_3$ stacks as a function of the varying anneal temperature.

Table S1: Electrical properties of the as-deposited ZnO and ZnO:Al (~50 nm thickness and Zn:Al cycle ratio of 15:1) extracted from Hall-effect measurements.

Sample	Carrier concentration (10^{19} cm^{-3})	Mobility (cm^2/V s)	Resistivity (10^{-3} Ω cm)
ZnO as-dep.	3.05	13.50	15.16
ZnO:Al (15:1) as-dep.	12.3	5.02	5.07

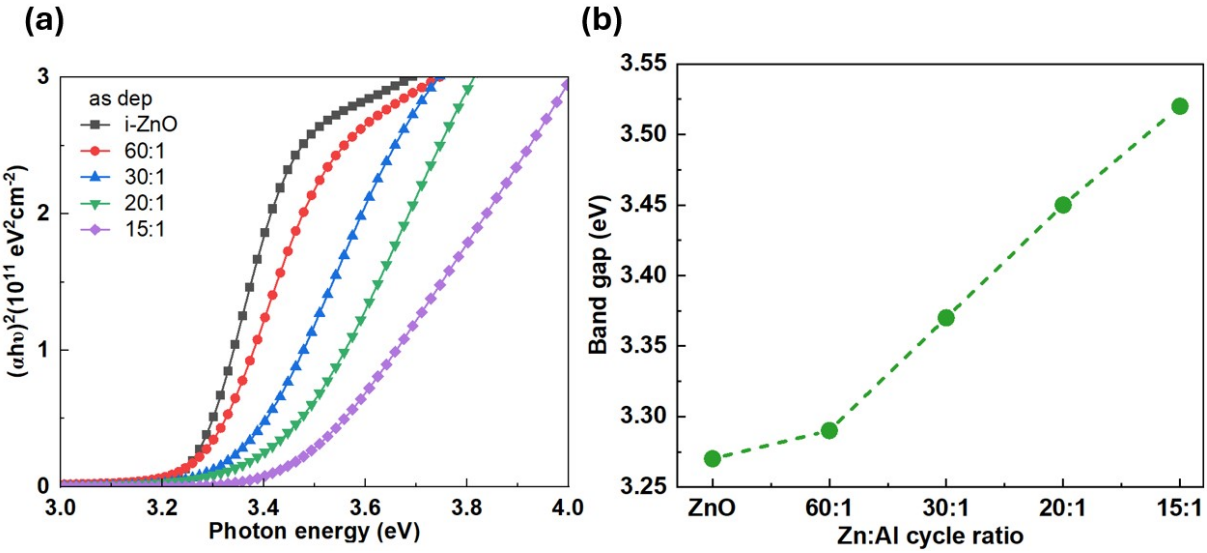

Figure S5: (a) Optical band gap extraction via Tauc plot and (b) resulting optical band gap of as-deposited intrinsic ZnO and ZnO:Al films with varying Zn:Al cycle ratio.

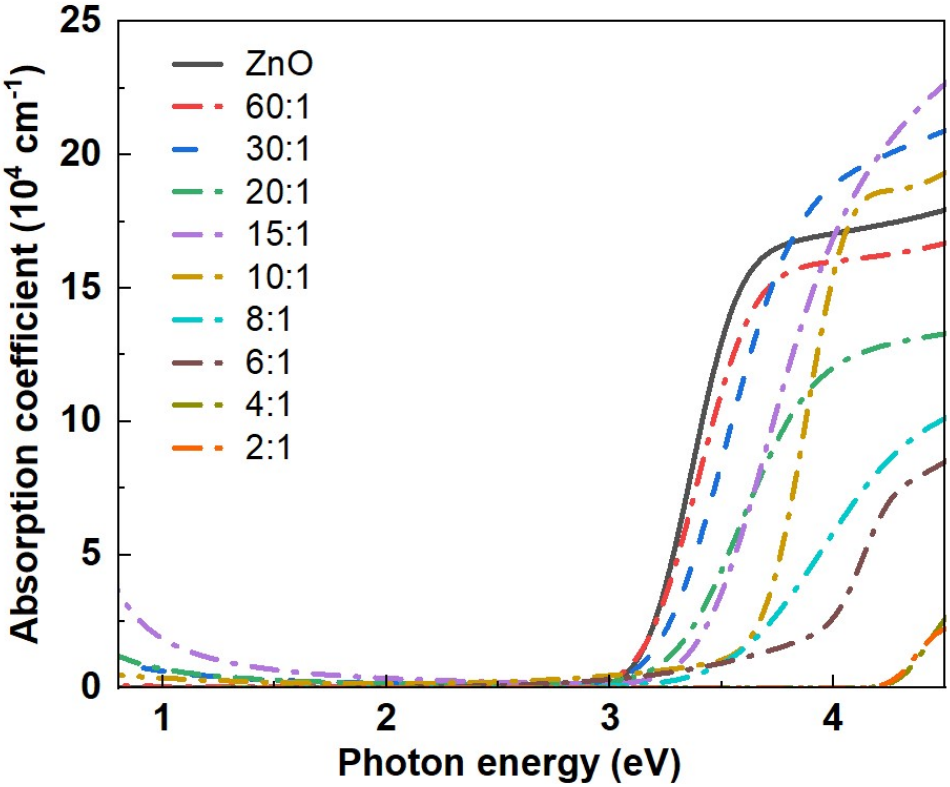

Figure S6: Absorption coefficient of ZnO:Al films with varying Zn:Al cycle ratio after Al_2O_3 capping and annealing.

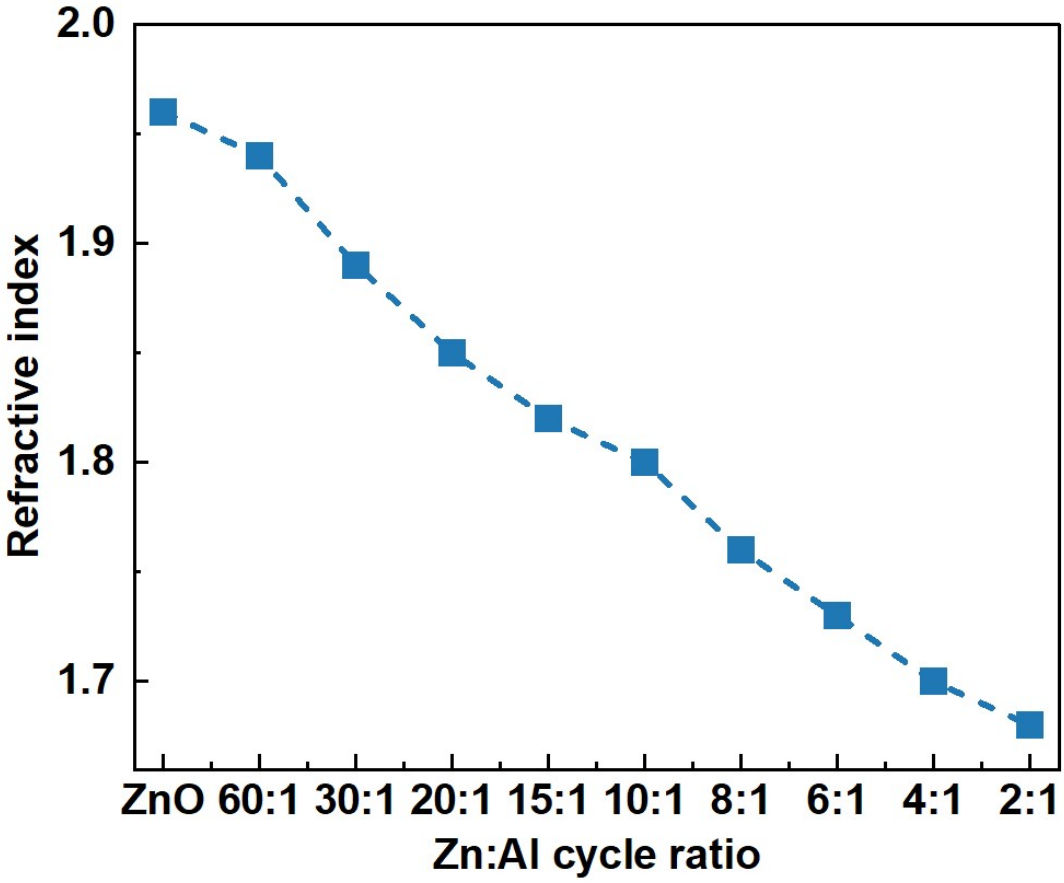

Figure S7: The refractive index of ZnO and ZnO:Al films with varying Zn:Al cycle ratio after Al_2O_3 capping and annealing.

Table S2: Crystallite size of SiO_x/ZnO:Al films without annealing, as assessed by XRD.

Sample	Crystallite size (nm)
ZnO	12.89
60:1	13.00
30:1	14.13
20:1	14.45
15:1	13.65

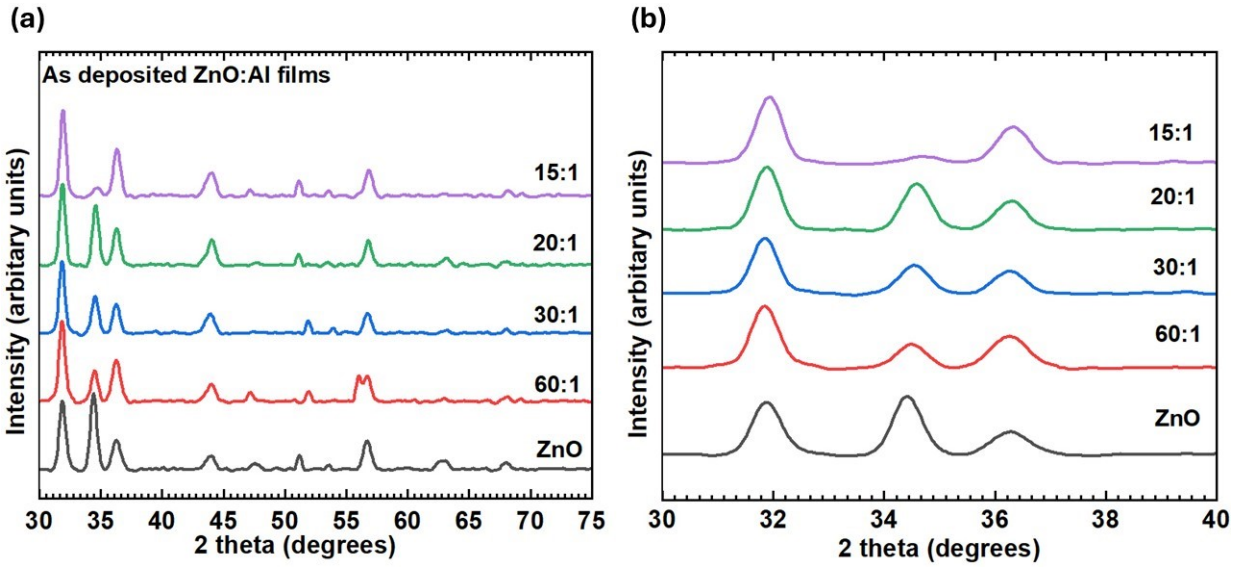

Figure S8: XRD spectra for as-deposited ZnO and ZnO:Al films with different Zn:Al cycle ratios **(a)** from 30º to 75º and **(b)** from 30º to 40º

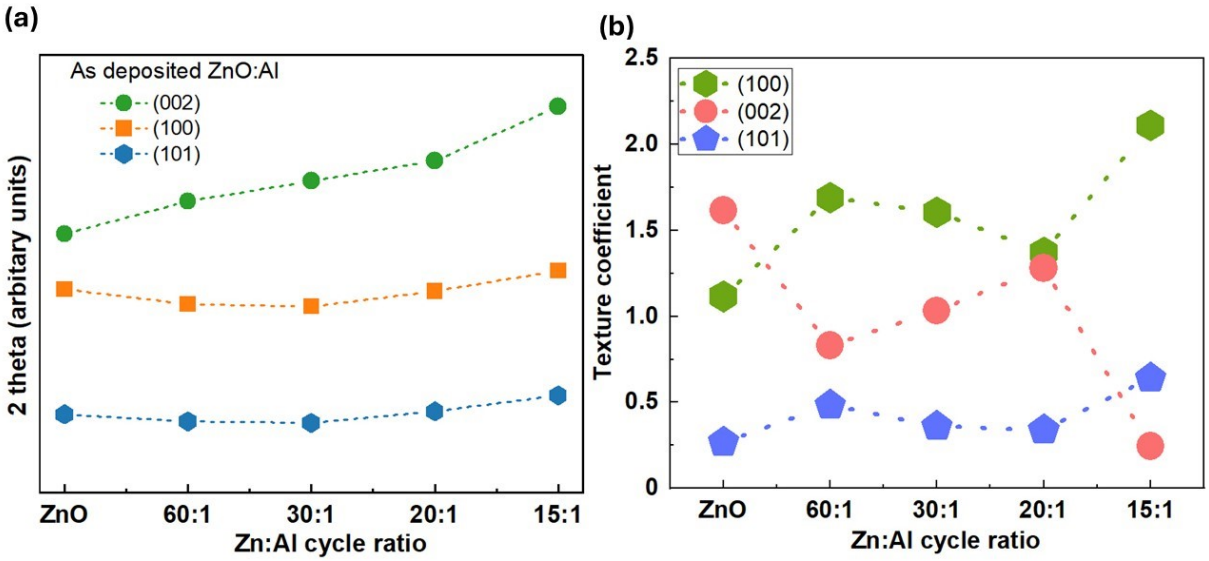

Figure S9: (a) 2 theta angles and (b) texture coefficients for the (100), (002) and (101) diffraction peaks of the as-deposited ZnO and ZnO:Al films with varying Zn:Al cycle ratio.

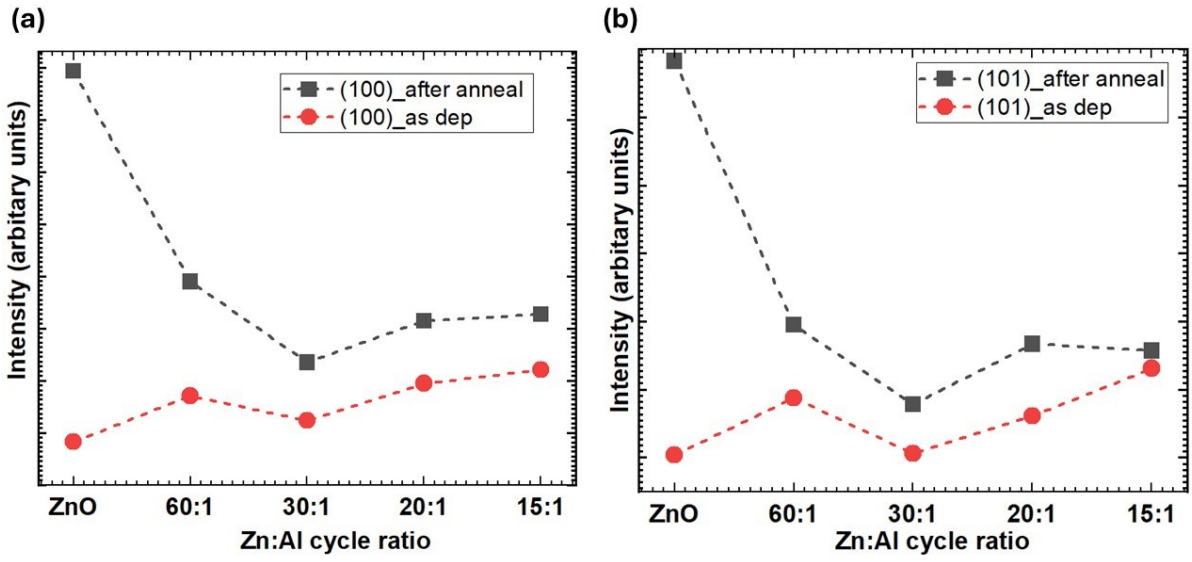

Figure S10: XRD **(a)** (100) peak intensity and **(b)** (101) peak intensity changes with varying Zn: Al cycle ratio, before and after annealing.