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Supplementary Information

Sub-second photonic processing of solution-deposited single layer and heterojunction metal oxide thin-film transistors using a high-power xenon flash lamp

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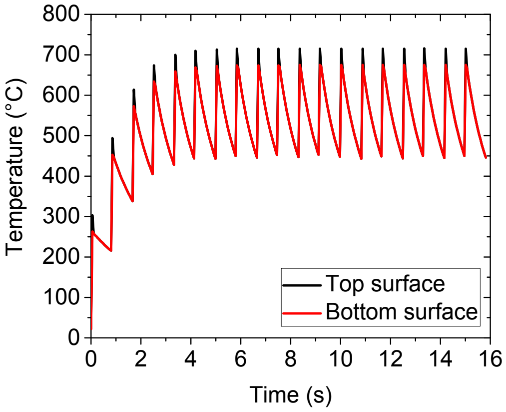

Figure S1. Simulations of the temperature profile on top and on the bottom of the In_2O_3-coated Si/SiO_2 substrates after exposure to 20 xenon light pulses using energy densities of 5 J/cm^2 and pulse lengths of 500 µs at a fire rate of 1.2 Hz using the SimPulse software tool.

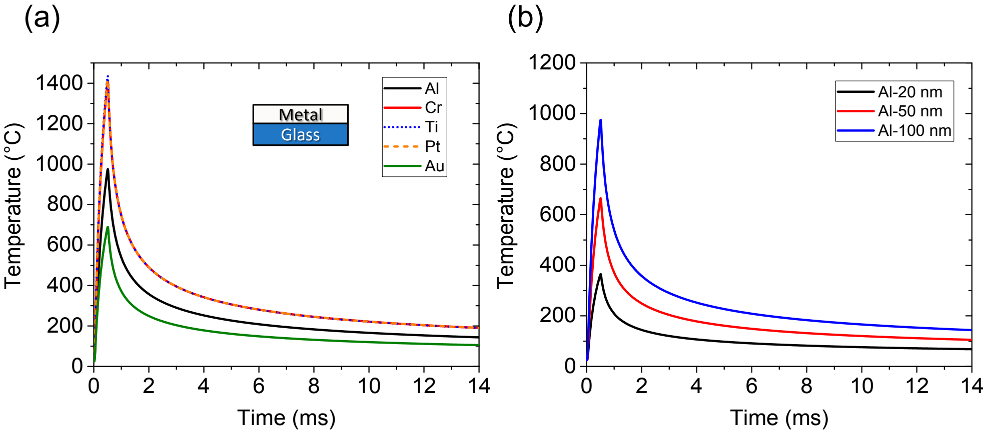

Figure S2. Comparison of the thermal response of; (a) different metals with fixed thicknesses of 100 nm, and (b) an Al layer with varying thicknesses, both on borosilicate glass substrates (thickness of 1.1 mm) as simulated using SimPulse. The graphs show the temperature on top of the metal surface after a single xenon light pulse with a radiant energy density of 5 J/cm^2 and a pulse length of 500 µs.

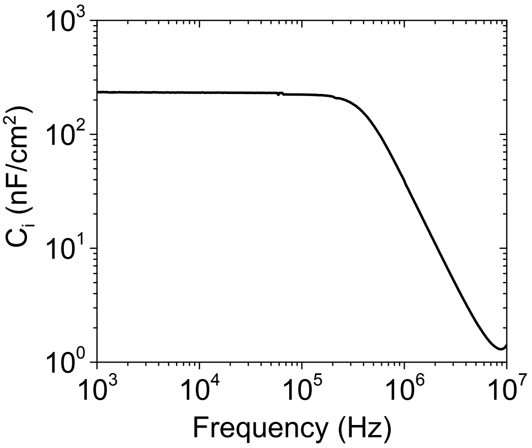

Figure S3. Geometric capacitance measured for the bilayer AlO_X/ZrO_X dielectric as a function of small alternating-current (AC) signal frequency. Characterisation was carried out using a metal-insulator-metal (Al/dielectric/Al) structure. A value of 235 nF/cm^2 is calculated at a frequency of 10^3 Hz.

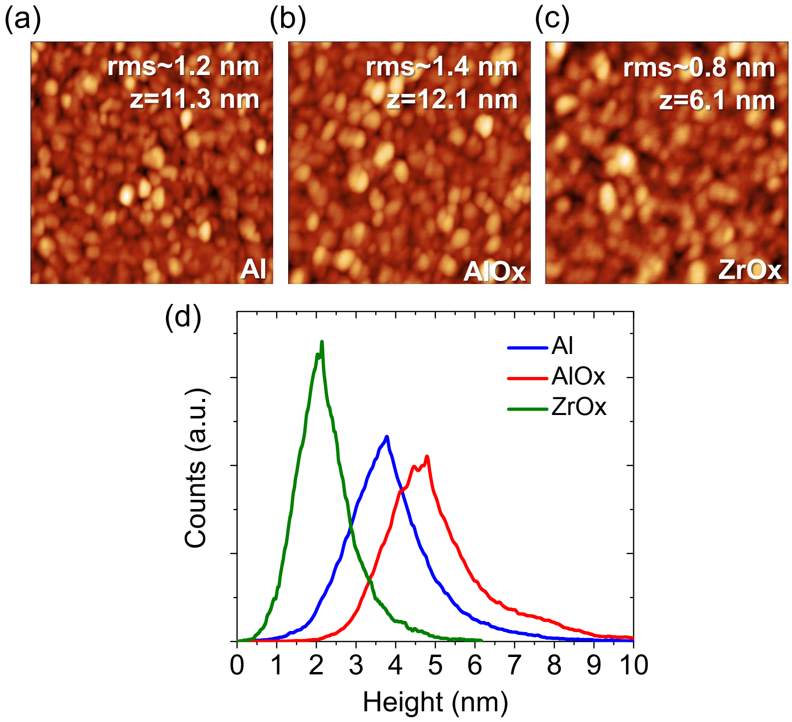

Figure S4. Atomic force microscopy (AFM) images of the surface topographies of: (a) a representative Al gate electrode, (b) Al/AlO_X formed via UV exposure, and (c) Al/ AlO_X/ZrO_X grown by spin-coating the zirconia precursor solution onto the Al/AlO_X electrode followed by photochemical conversion. (d) Corresponding height distributions for the three samples. Broader height distribution indicates a rougher surface topography.

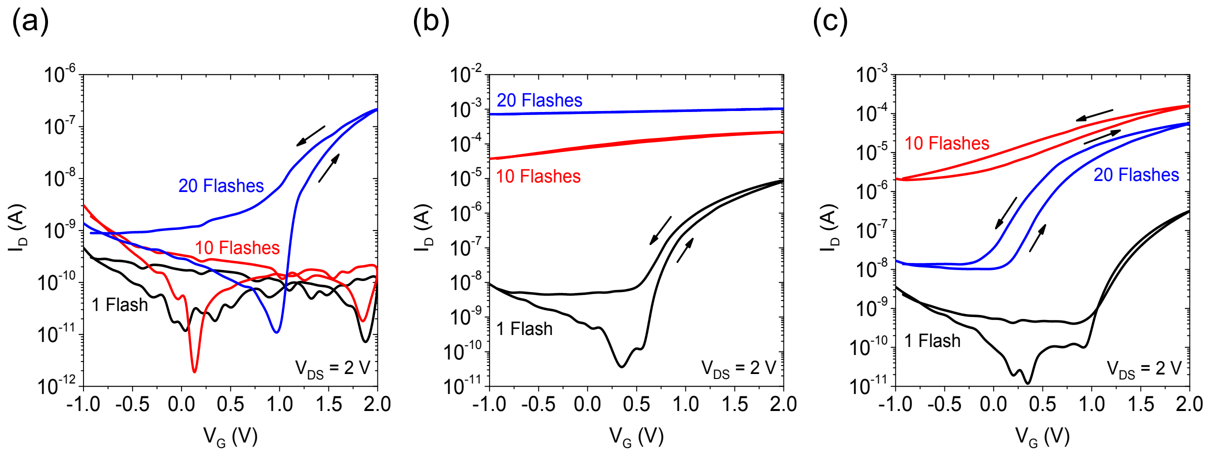

Figure S5. Evolution of the transfer curves for In_2O_3 transistor devices photonically cured using different flash parameters with pulse lengths and radiant energy densities of (a) 500 µs at 4 J/cm^2 (b) 300 µs at 5 J/cm^2 and (c) 300 µs at 4 J/cm^2 at a constant fire rate of 1.2 Hz.

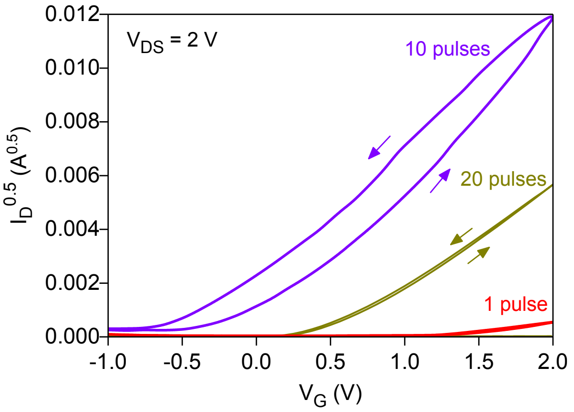

Figure S6. $I_D^{0.5}$ vs. V_G plots measured for In_2O_3 TFTs after soft-baking at 130 °C and subsequently exposed to 1, 10 and 20 xenon light pulses with energy density per pulse and duration of 5 J/cm^2 and 500 µs, respectively. Multiple pulse exposure was performed at a fire rate of 1.2 Hz.

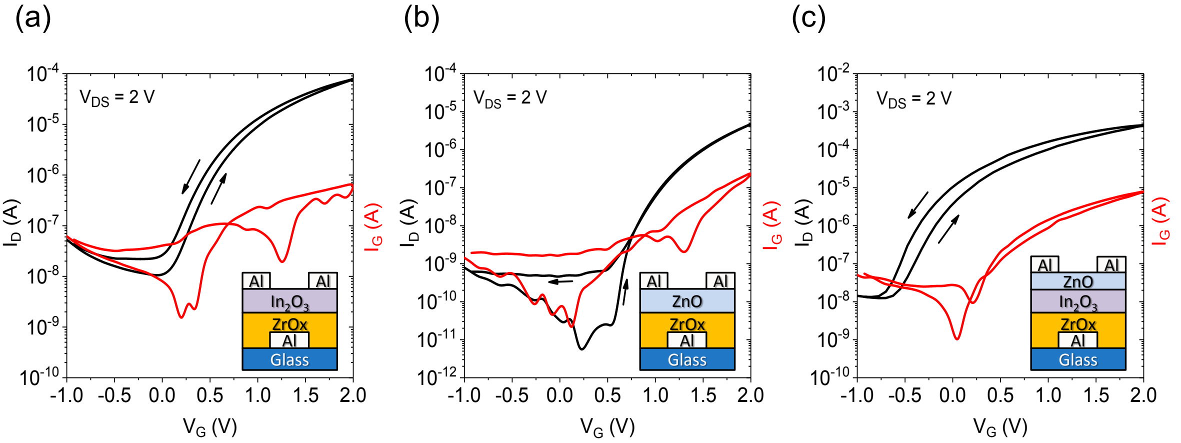

Figure S7. Transfer characteristics of (a) In_2O_3, (b) ZnO and (c) In_2O_3/ZnO transistors prepared via conventional thermal annealing at 250 °C for 1 h in ambient air.

Table S1. Electrical parameters of solution-processed ZnO transistors fabricated using different post-deposition treatment conditions.

Processing conditions	μ_{sat} ($cm^2V^{-1}s^{-1}$)	V_{TH} (V)	On/off ratio
Baking at 110 °C for 1 hour	0.3	1.1	5×10^2
1 Flash ($5\ J/cm^2$, 500 µs)	0.3	0.4	6×10^3
20 Flashes ($5\ J/cm^2$, 500 µs)	1.7	0.6	2×10^4
Thermal annealing at 250 °C for 1 hour	1.5	1.1	1×10^4

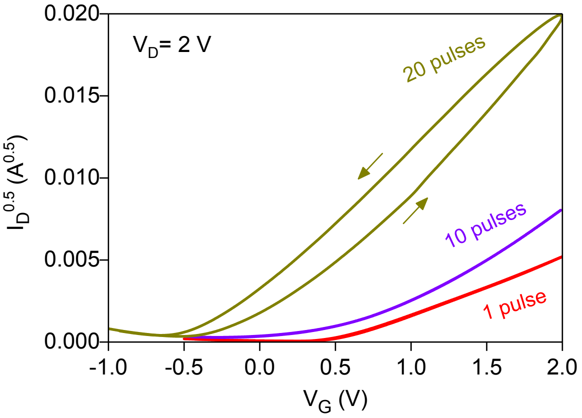

Figure S8. $I_D^{0.5}$ vs. V_G plots of heterostructure thin-film transistors consisting of photonically cured In_2O_3 films using 20 xenon pulses and single layer ZnO dried at 110 °C which were subsequently exposed to 1, 10 and 20 xenon flash pulses of energy densities of $5\ J/cm^2$ and pulse durations of 500 µs at a fire rate of 1.2 Hz

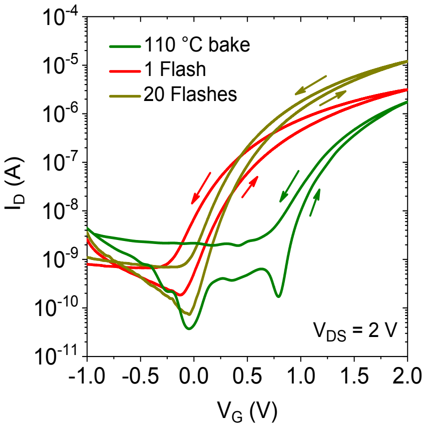

Figure S9. Evolution of the transfer curves for ZnO transistor devices photonically cured using flash parameters with pulse lengths and radiant energy densities of 500 µs at $5\ J/cm^2$ at a constant fire rate of 1.2 Hz.

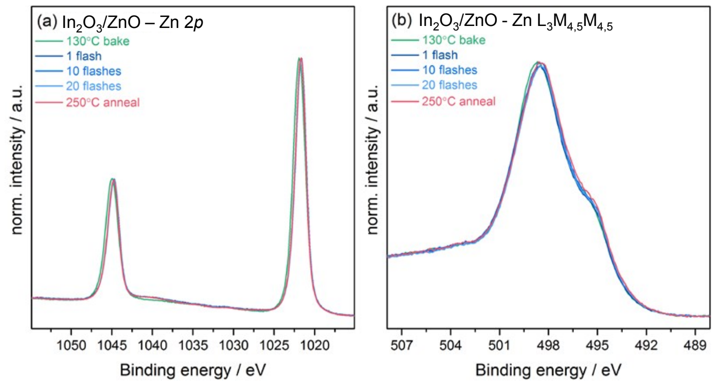

Figure S10. (a) Zn 2p core level and (b) Zn L3M4,5M4,5 Auger spectra for In_2O_3/ZnO heterostructure samples prepared using different methods including; soft-bake (130 °C bake), photonic conversion (1 to 20 flashes/pulses) as well as thermal annealing at 250 °C (anneal).

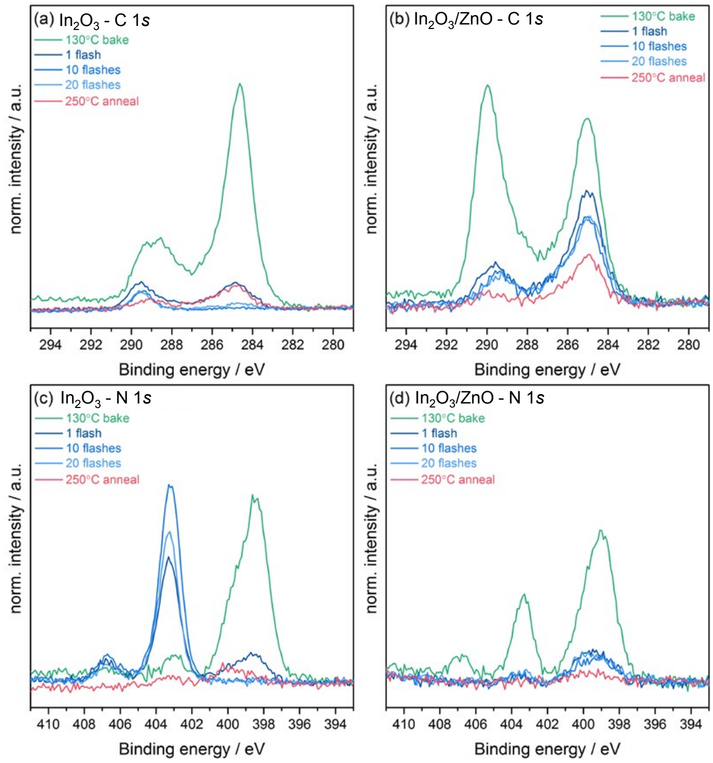

Figure S11. C and N 1*s* core level XPS spectra for (a) and (c) In_2O_3 layer, and (b) and (d) In_2O_3/ZnO heterostructure samples prepared using different methods including; soft-bake (130 °C bake), photonic conversion (1 to 20 flashes/pulses) as well as thermal annealing at 250 °C (anneal).

Table S2. Relative atomic ratios from peak fit analysis of XPS core level spectra in In_2O_3 and In_2O_3/ZnO.

Sample	In:N (In_2O_3)	Zn:N (In_2O_3/ZnO)
130ºC bake	88:12	94:6
1 Flash	92:8	98:2
10 Flashes	91:9	99:1
20 Flashes	92:8	98:2
250ºC anneal	98:2	99:1