Enhanced broadband non-degenerate two-photon absorption in Ga-doped ZnO for ultrafast all-optical switching: supplementary material

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1. Full width of half maximum at different wavelengths

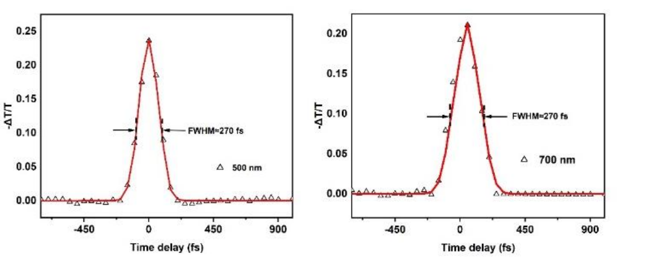

Fig. S1. Full width of half maximum at wavelengths of 500nm and 700nm.

2. Schematic diagram of an all-optical switching

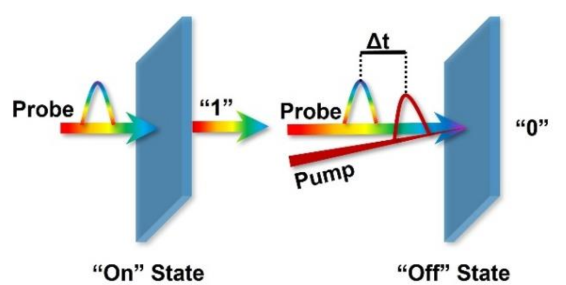

Fig. S2. All-Optical Switching ON/OFF State Schematics.

3. Theoretical fitting using different models

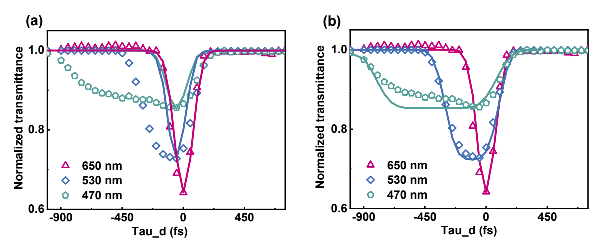

Fig. S3. (a) Normalized transmittance at different probe wavelengths under 650 nm excitation, the solid lines represent the theoretical fitting without considering GVM; (b) Normalized transmittance under the same probe and excitation wavelength, the solid lines represent the theoretical fitting with the walk-off model.

4. Effect of thickness and pulse width on walk-off parameters

The walk-off parameter ρ is given by:

$$\rho = \frac{L}{\omega_p \cdot c}\left[n - \lambda\frac{dn}{d\lambda} - \left(n_p - \lambda_p\frac{dn}{d\lambda_p}\right)\right] = \frac{L}{\omega_p \cdot c}\Delta n_g$$

$$C_{ts} = \frac{\tau}{L}\left(\tau = \frac{\omega_p}{1.6651}\right) \quad (1)$$

where L represents the sample thickness, ω_p denotes the pump pulse width, c is the speed of light and n (n_p) refers to the linear refractive index of the material at the probe wavelength (pump wavelength), the symbol λ (λ_p) indicates the probe wavelength (pump wavelength). The threshold C_{ts} represents the threshold value for walk-off, when this value is less than 2.30 ps/mm, the TAS obtained from the experiment needs further correction to achieve an accurate TPA spectrum for GZO

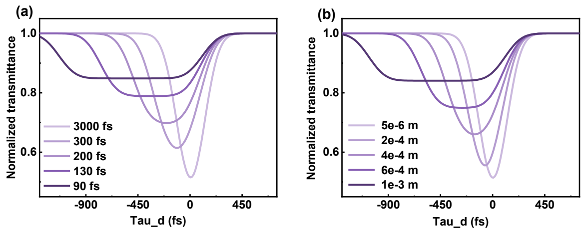

Fig. S4. (a) L = 0.5mm, the impact of different pulse widths on walk-off; (b) The pump pulse width is 190 fs, and the impact of different sample thickness on walk-off.

Table S1. The pump wavelength of 650 nm, the corrected TAS coefficient at different detection wavelengths

ω_p (ps)	0.2	0.4	0.6	1.0	1.5
L (mm)	0.053	0.105	0.157	0.261	0.392
ρ	0.506	0.507	0.507	0.506	0.507
C_{ts} (ps/mm)	2.303	2.302	2.301	2.304	2.305

5. The corrected TPA coefficients with 750 nm excitation wavelengths

Table S2. The β'_{ND} at different detection wavelengths under 750 nm excitation wavelength

Probe Wavelength (nm)	ρ	β_{ND} (10^{-11}m/W)	β'_{ND} (10^{-11}m/W)
470	16.0	2.80	17.58
480	14.0	3.20	17.33
510	10.0	4.40	16.97
580	4.0	6.20	10.08
650	0.1	4.30	4.30

6. Nondegenerate dispersion relations in different material

Table S3. Non-degenerate TPA coefficients of GZO, ZnS, GaAs and ZnSe (ZnS ZnSe and GaAs are from references[1], [2]and[3], respectively).

β'_{ND} (ω_1; ω_2) (cm/GW)							
ω_2/ω_1	β'_{ND} (GZO)	ω_2/ω_1	β'_{ND} (ZnS)	ω_2/ω_1	β'_{ND} (GaAs)	ω_2/ω_1	β'_{ND} (ZnSe)
1.06	1.62	1.40	0.07	1.10	~5.4	1.00	~2.0
1.15	4.30	1.45	0.33	1.20	~5.5	1.45	~3.1
1.29	10.08	1.50	0.90	1.30	~6.5	1.65	~4.0
1.47	16.97	1.55	1.51	1.42	~7.3	1.85	~4.5
1.56	17.33	1.60	2.00	1.55	~7.9	2.25	~5.0
1.60	17.58	1.67	2.88	1.72	~9.3	2.50	~6.0

References

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