

Supplementary Information

Photo-induced oxygen vacancy modulation in solution-processed $\text{TiO}_2/\text{ZnFe}_2\text{O}_4$ heterointerface for all-oxide dual-mode neuromorphic logic memory

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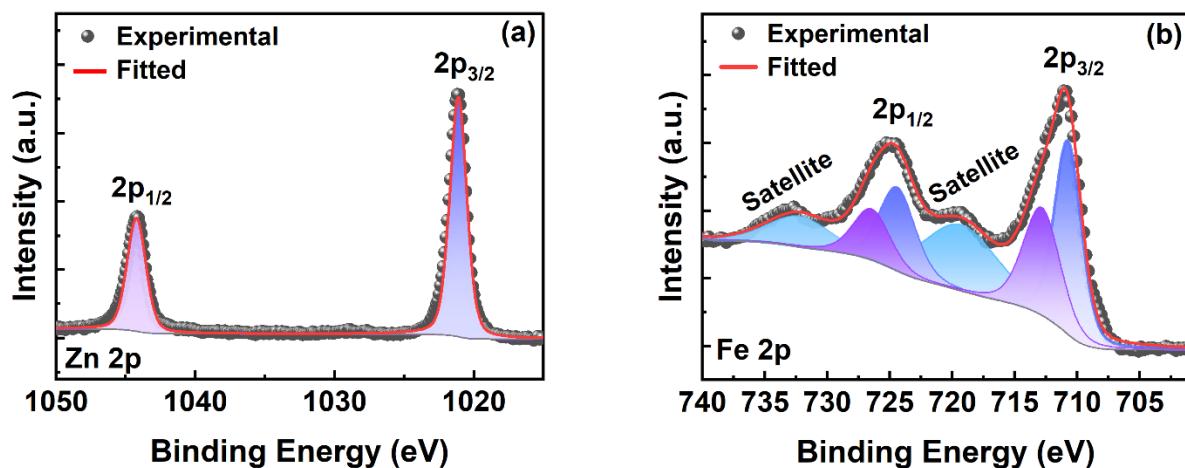


Fig. S1. XPS narrow scan spectra for (a) Zn 2p, and (b) Fe 2p.

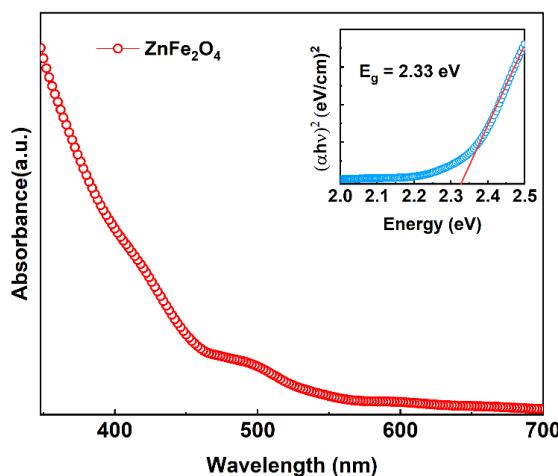


Fig. S2. UV-vis absorption spectrum and corresponding Tauc plot (inset) for ZFO film.

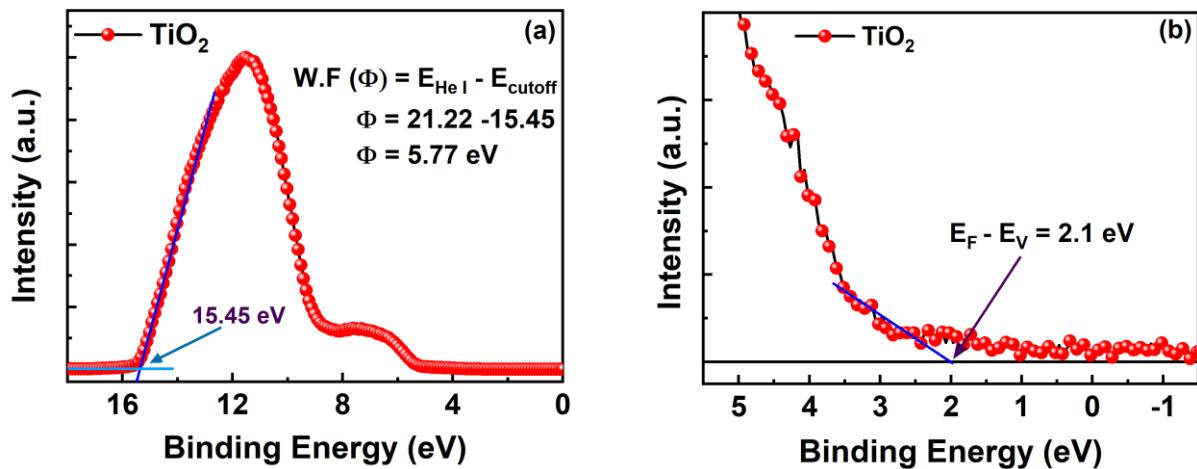


Fig. S3. (a) UPS spectrum for TiO_2 , (b) valence band position of TiO_2 thin film.

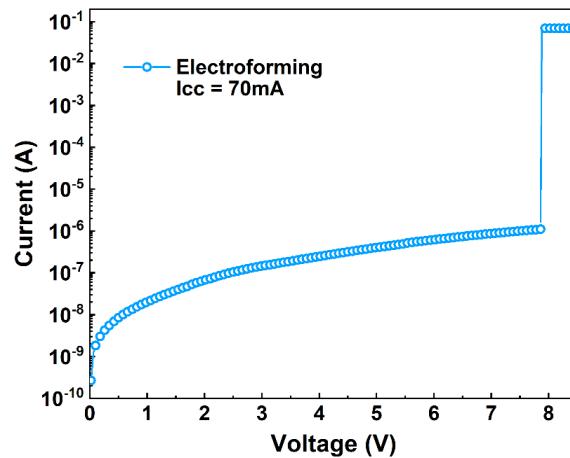


Fig. S4. Semi-logarithmic I - V plot for the electroforming process in the FTO/ TiO_2 /ZFO/Ag device.

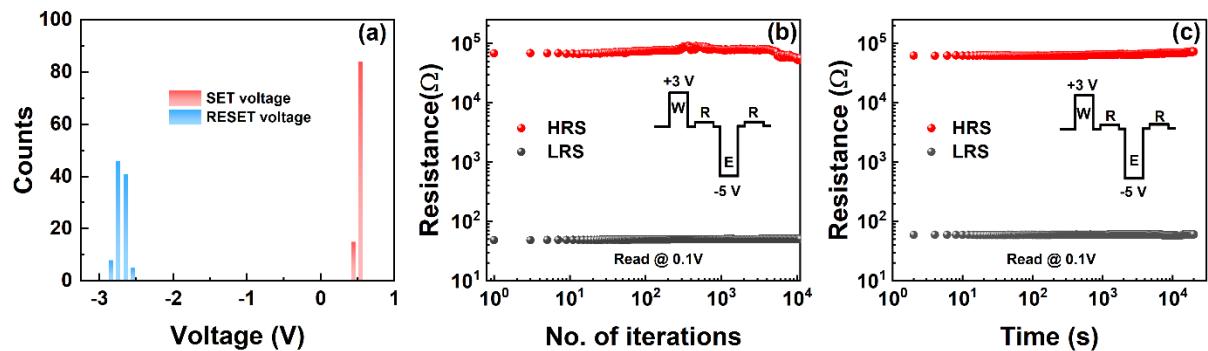


Fig. S5. (a) Distribution of SET-RESET voltages for the initial 100 cycles. (b) Endurance, and (c) retention data plot for the FTO/ TiO_2 /ZFO/Ag device.

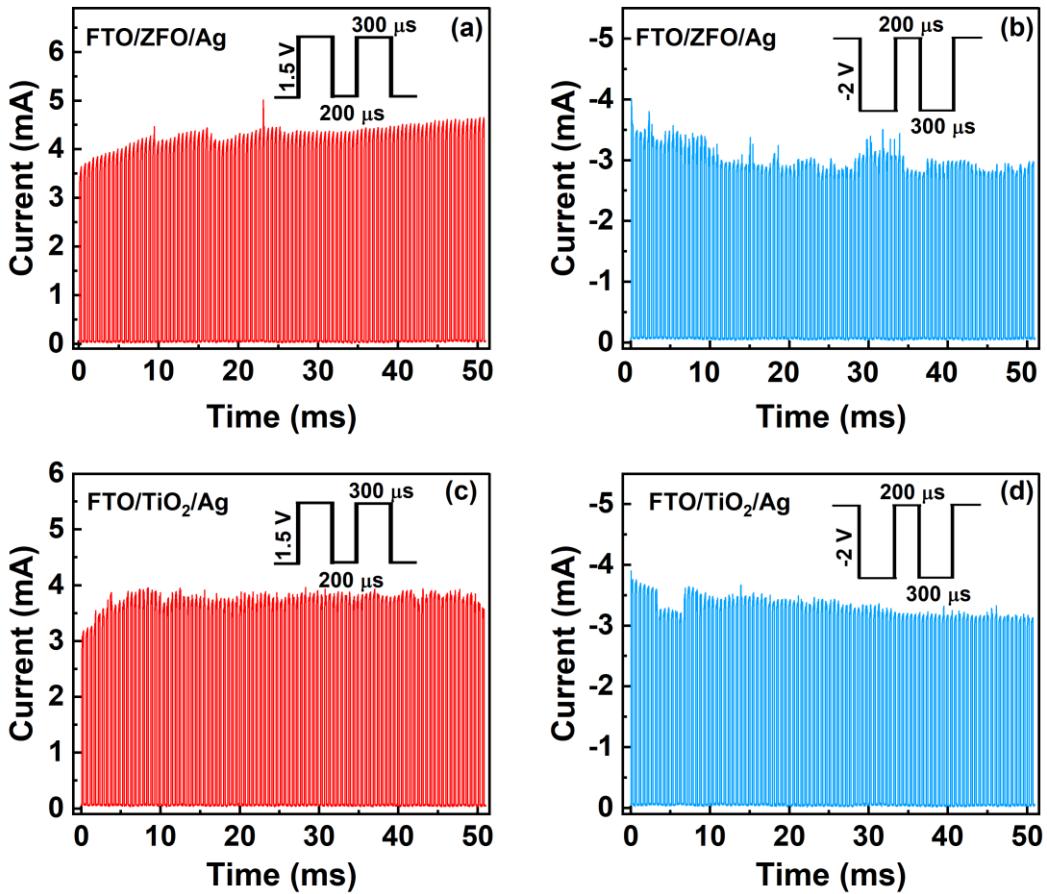


Fig. S6. Post-synaptic current response in FTO/ZFO/Ag device for 150 consecutive (a) positive (+1.5 V) and (b) negative (-2 V) pulse amplitudes. Post-synaptic current response in FTO/TiO₂/Ag device for 150 consecutive (c) positive (+1.5 V) and (d) negative (-2 V) pulses.

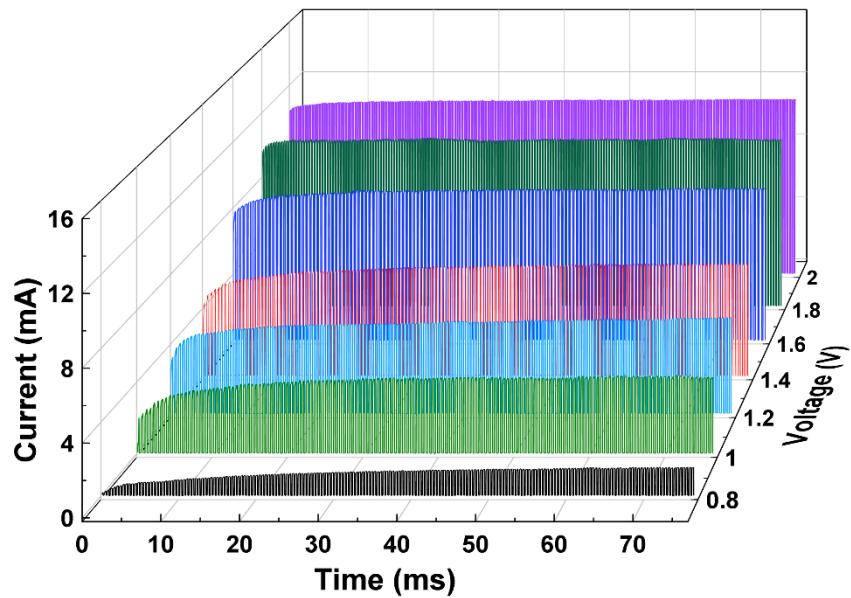


Fig. S7. Synaptic potentiation response of the FTO/TiO₂/ZFO/Ag device corresponding to varying pulse amplitudes ranging from 0.8 V to 2 V, with a pulse width of 500 μs and a 200 μs pulse interval.

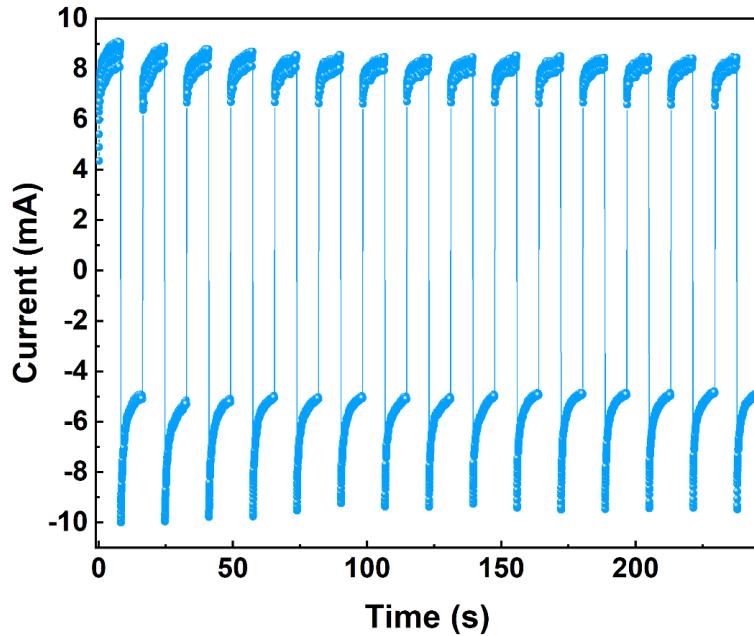


Fig. S8. Current modulation under 20 positive (1.4 V) and 20 negative (-1.8 V) pulses for 15 consecutive cycles.

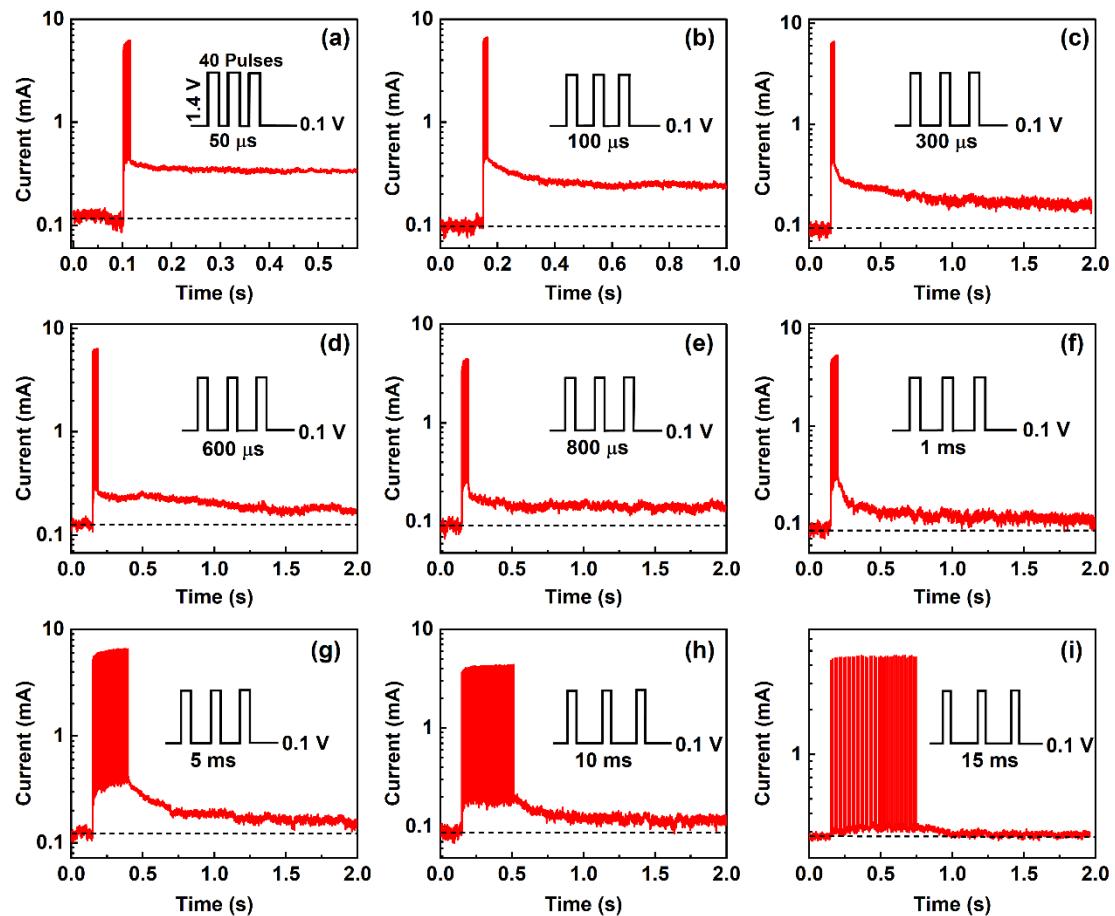


Fig. S9. SRDP behavior with varying pulse interval/rate shows a decrease in EPSC for longer pulse durations due to enough charge relaxation time between consecutive pulses. The inset shows the pulse parameters for device testing.

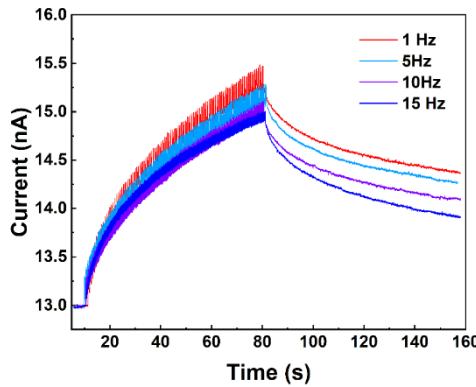


Fig. S10. EPSC behavior of the device decreases as the frequency of light pulses increases.

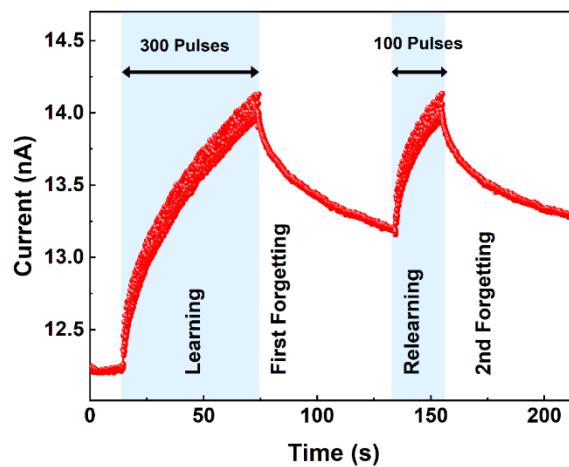


Fig. S11. Change of EPSC confirms optical pulse-induced simulation of learning, forgetting, and relearning behavior under 445 nm/10 mW cm⁻² illumination.

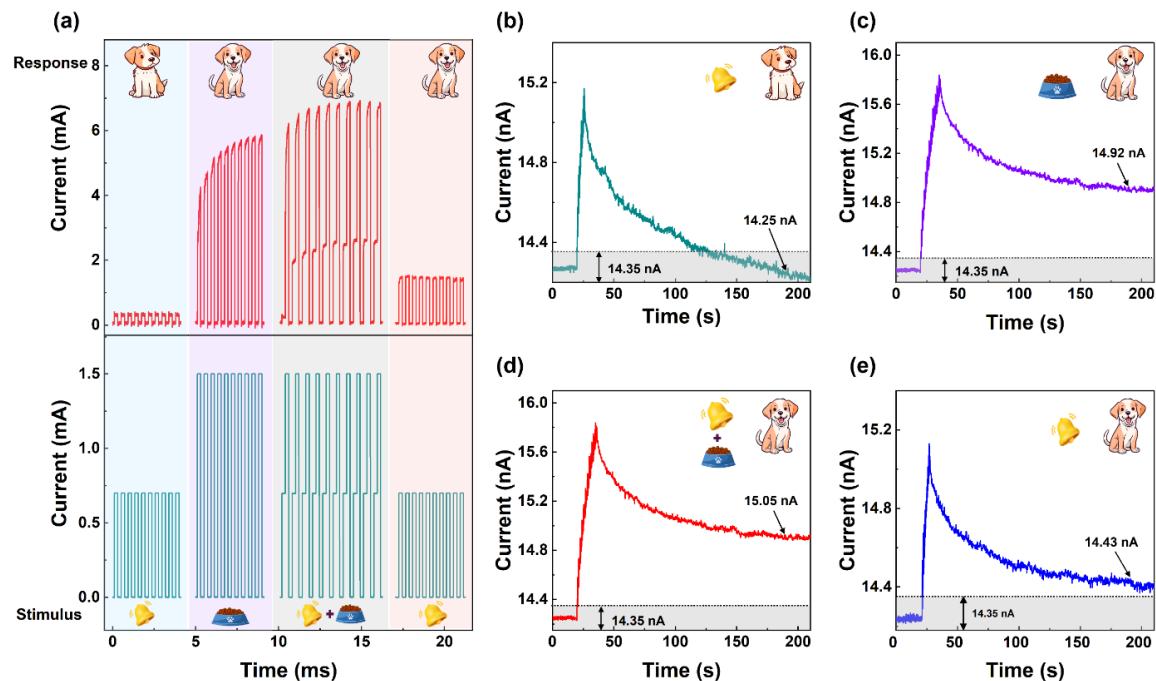


Fig. S12. Pavlov's classical conditioning under (a) electrical and (b-e) optical stimuli.

Reservoir Computing

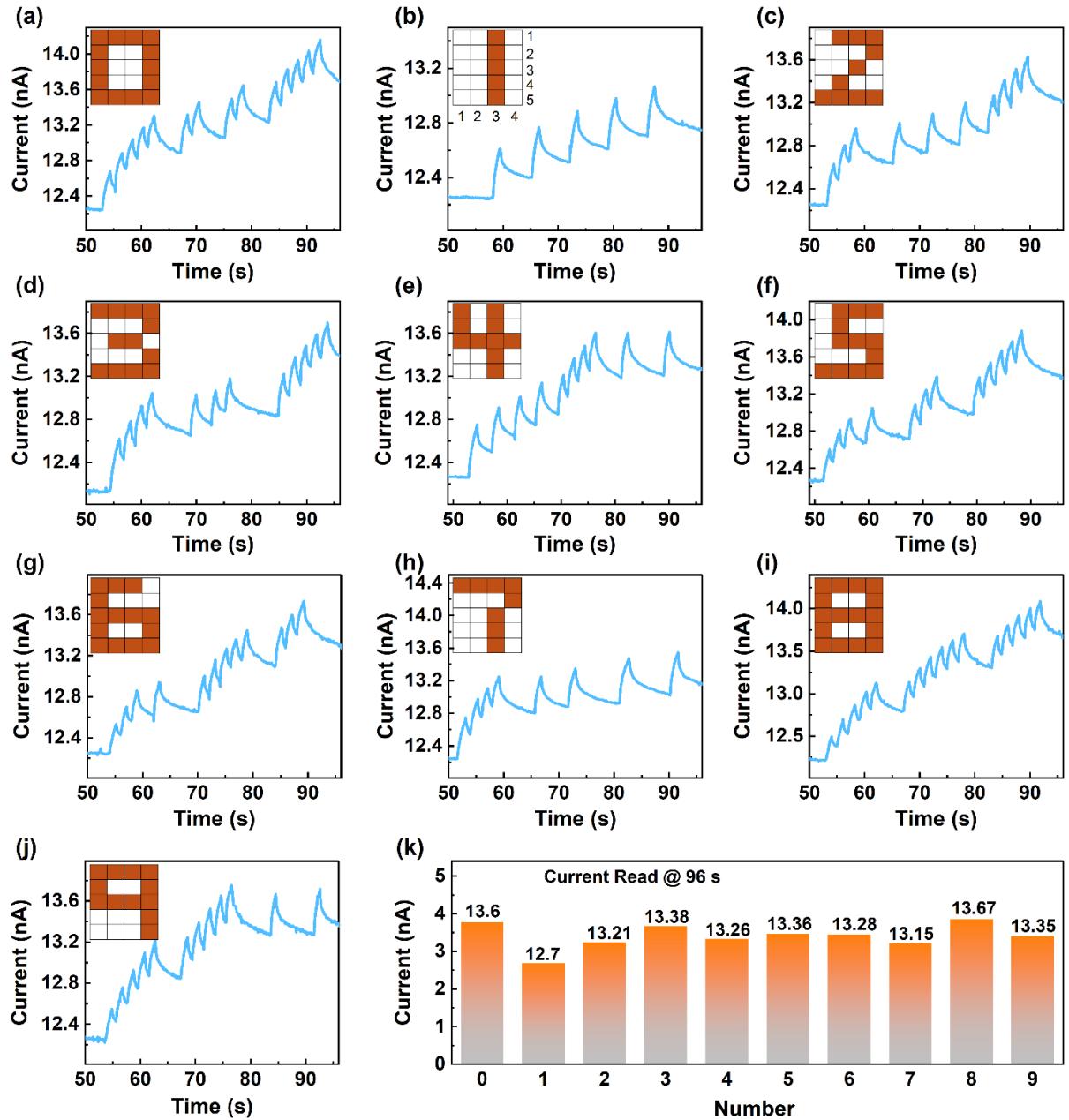


Fig. S13. EPSC current measurement for digit pattern from 0 to 9.

Note: Here, a reservoir computing system is described where the input layer is formed by processed images of digits 0-9, each represented as a 4×5 pixel matrix and then converted into a 1×20 pixel sequence, as illustrated in Figure S13. Each digit image is transformed into a linear sequence of temporal optoelectronic pulses, for example, “1110100011111001” for digit “6”. Here, “1” denotes an optical ON/OFF pulse with a duration of 1s/1 s, while “0” corresponds to a 2 s OFF period, all applied at a read voltage of 0.1 V.