Supplementary Information

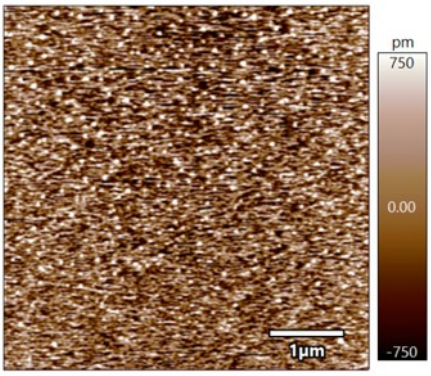

Figure S1. The surface morphology of the device scanned in the range of 5 μm×5 μm.

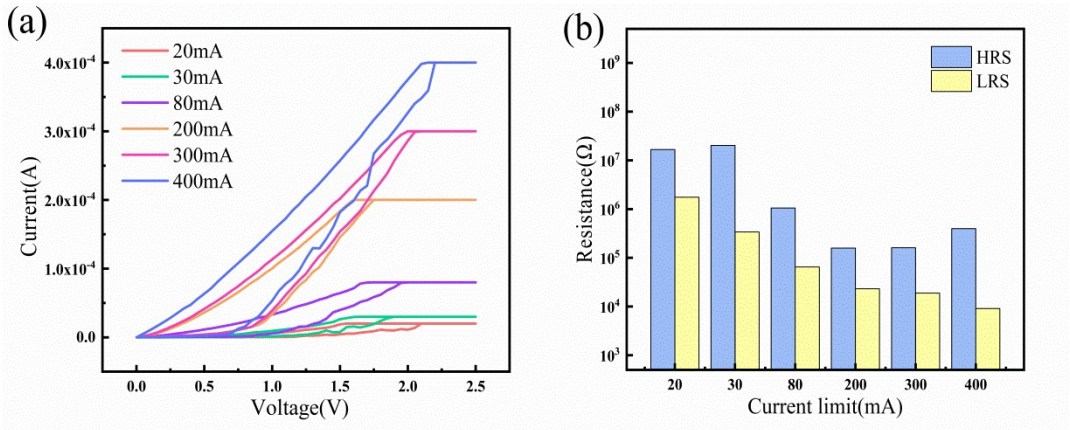

Figure S2. (a) Positive I-V curves at different limiting currents. (b) Statistics of high and low resistance under different limiting current.

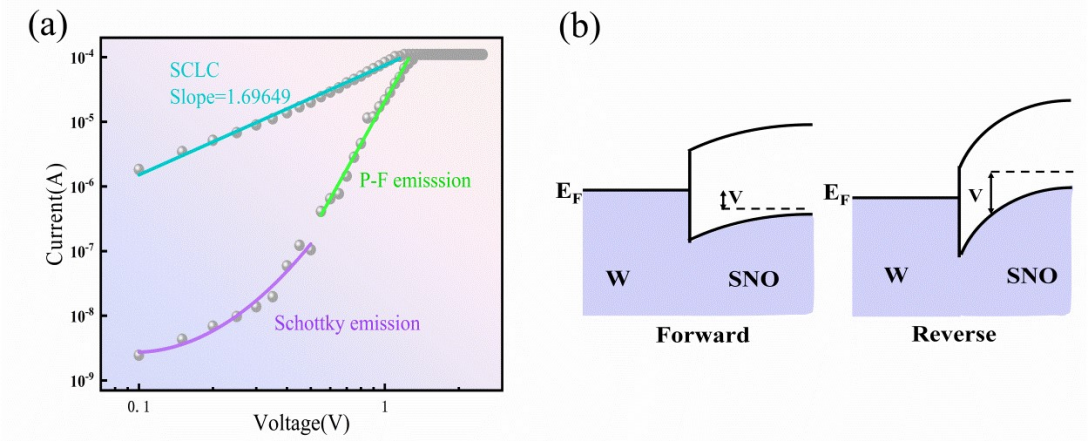

Figure S3. (a) Fitting schematic diagram of nonlinear I-V curve conductive mechanism of W/SNO/LSMO/STO memristor. (b) W/SNO interface band diagram.

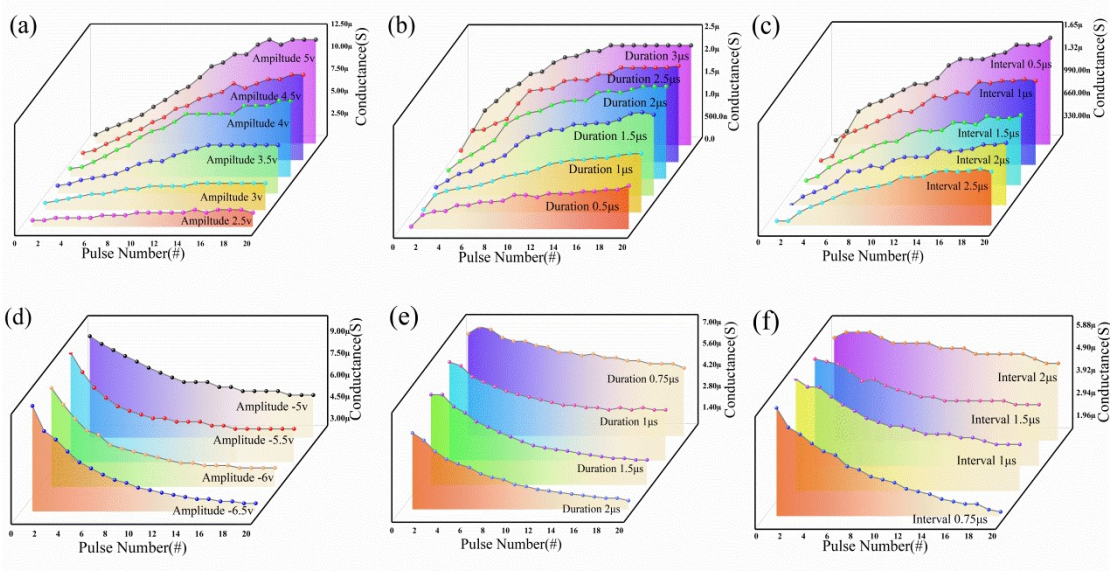

Figure S4. Device bidirectional conductance control: 20 pulses of different parameters are applied to the device. (a) Same pulse width (1 μs) and interval (1 μs), varying amplitude (from 2.5 V to 5 V). (b) Change the pulse width from 0.5 μs to 3 μs with the same pulse amplitude (5 V) and interval (1 μs). (c) Same pulse amplitude (5 V) and pulse width (1 μs), change the interval (from 0.5 μs to 2.5 μs). (d) Same pulse width (1 μs) and interval (1 μs), varying amplitude (from -5 V to -6.5 V). (e) Same pulse amplitude (-6 V) and interval (1 μs), varying pulse width (from 0.75 μs to 2 μs). (f) Same pulse amplitude (-6 V) and pulse width (1 μs), varying interval (from 0.75 μs to 2 μs).

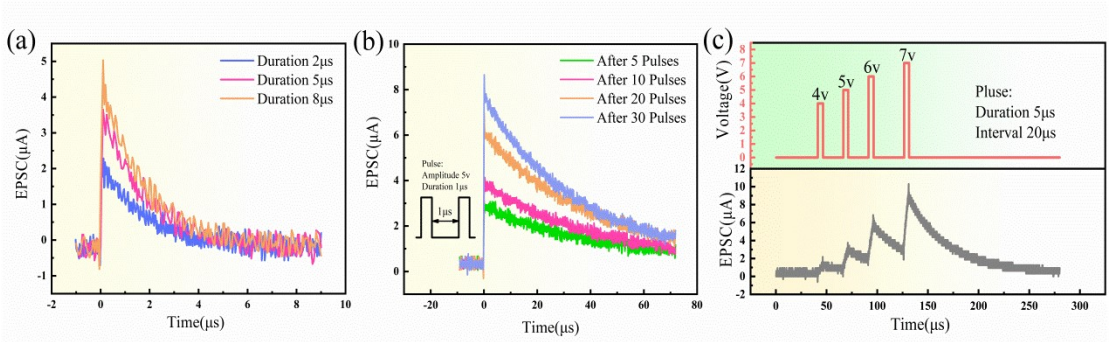

Figure S5. (a) EPSC with single pulse and different pulse widths (2 μs, 5 μs, 8 μs). (b) EPSC under different number of pulses. (c) EPSC generated by changing amplitude (4 V, 5 V, 6 V, 7 V) under pulse width of 5μs.

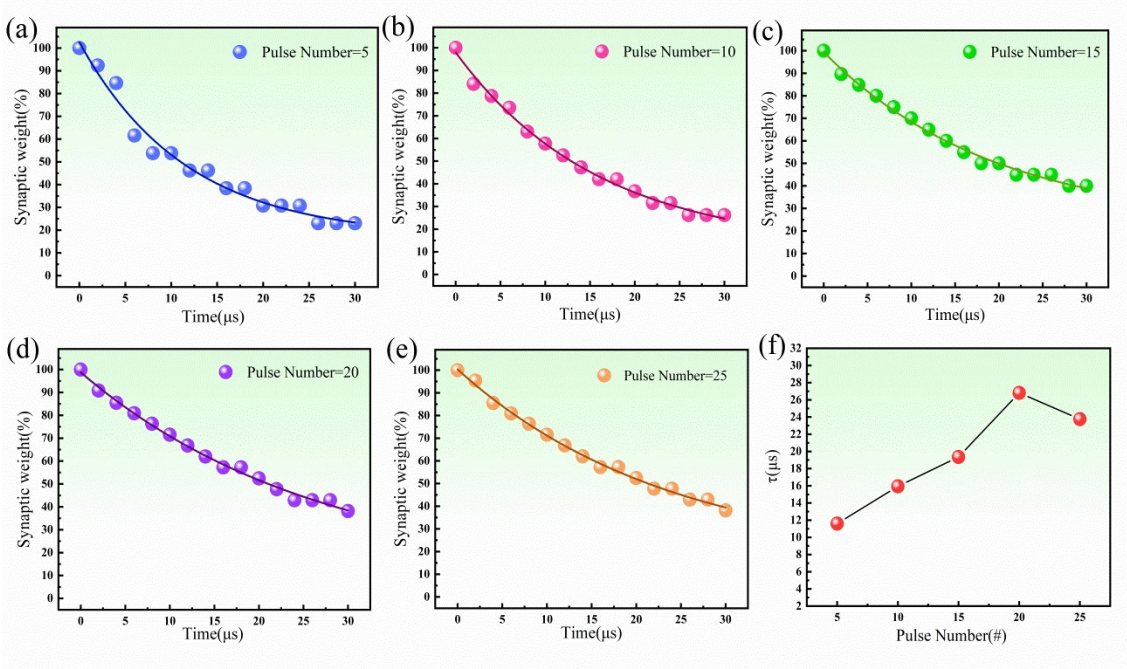

Figure S6. STP to LTP conversion. (a) - (e) are the change of pulse weight over time and its fitting curve under 5, 10, 15, 20 and 25 pulses respectively. (f) The relationship between relaxation time τ and the number of pulses.

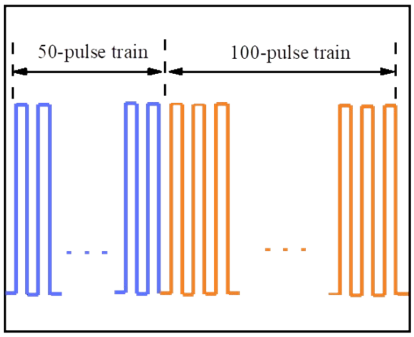

Figure S7. Schematic diagram of two pulses applied to the device. The first 50 and the last 100 pulses.

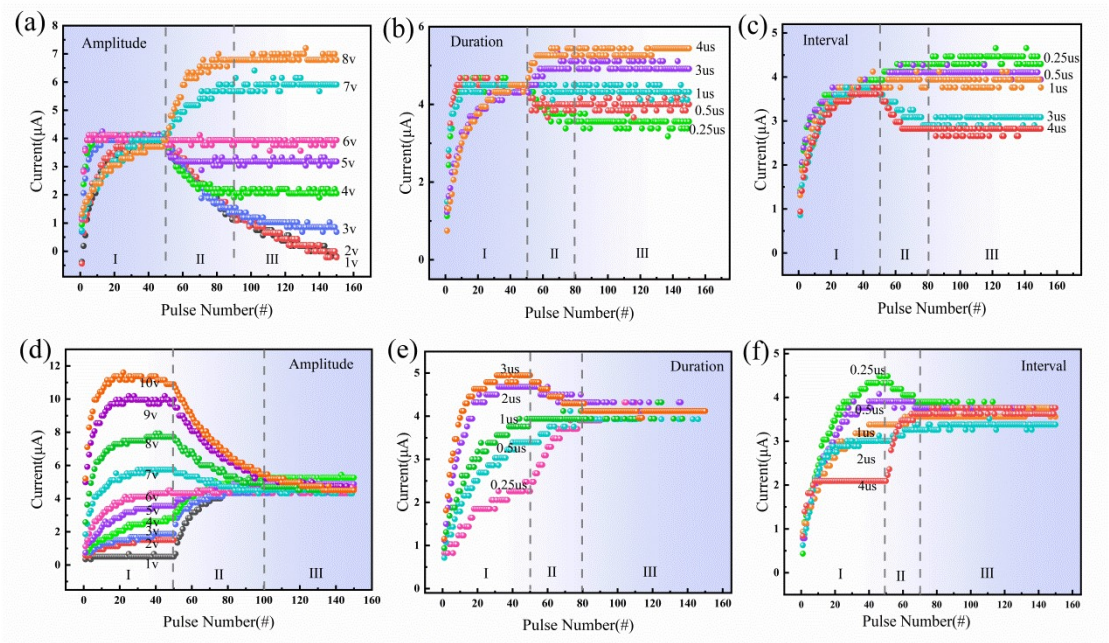

Figure S8. Device refractory period phenomenon demonstration. (a, b, c) 150 pulses are applied to the device, the first 50 pulses (pulse width 1 μs, amplitude 6 V, interval 1 μs) are the same, and the amplitude, width and interval of the next 100 pulses are changed respectively, and the current of the device changes. (d, e, f) 150 pulses are applied to the device, and the next 100 pulses (pulse width 1 μs, amplitude 6 V, interval 1 μs) are the same. The amplitude, width and interval of the first 50 pulses are changed respectively, and the current of the device changes.

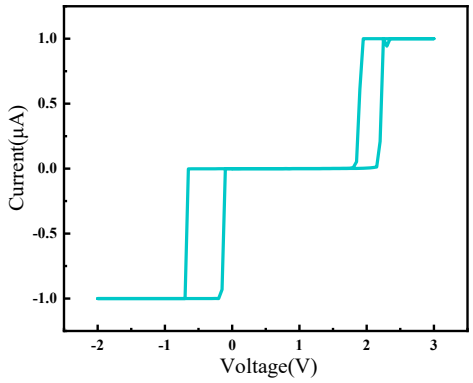

Figure S9. IV diagram of threshold device W/$LiNbO_3$/Pt/Ti/SiO_2/Si.