Supplementary Material for

Optoelectronic neuro-synaptic behaviors of antiferroelectric NaNbO3/n-GaN heterostructures

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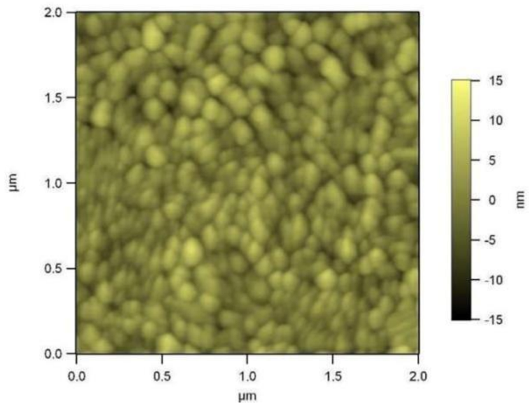

Fig. S1 AFM image of NNO/n-GaN heterostructure. The roughness of NNO thin film is 2.8±0.1nm.

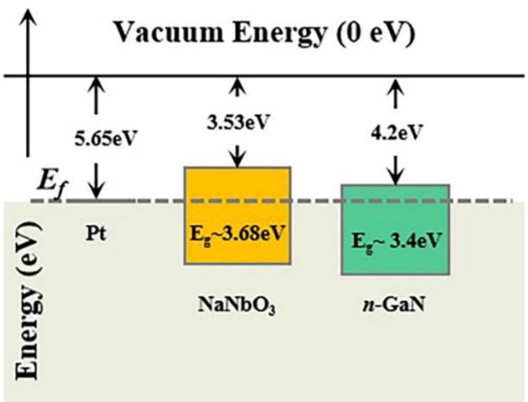

Fig. S2 Energy level diagrams of various materials for NNO/n-GaN heterostructure.

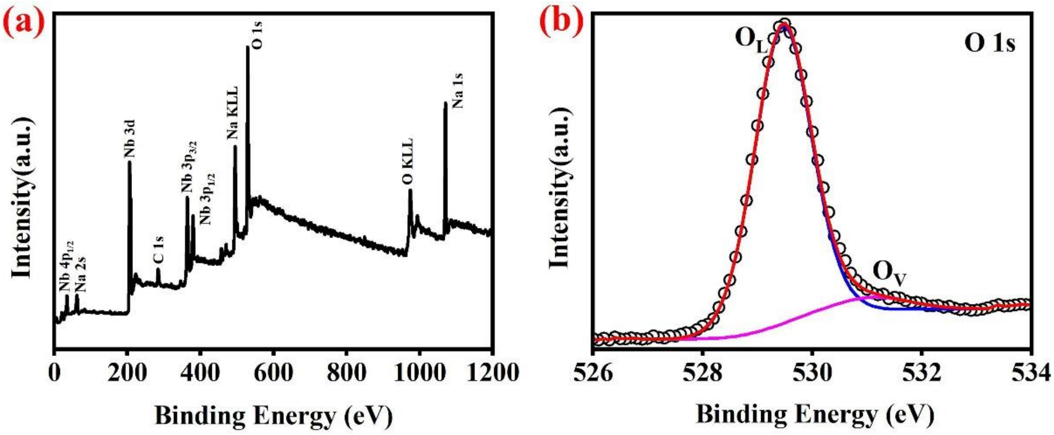

Fig. S3 XPS spectra of NNO/n-GaN heterostructure. (a) XPS survey spectra, (b) XPS narrow scan spectrum of O 1s. The XPS survey spectrum reveals that the samples mainly contain Na, Nb, and O element. The high-resolution O 1s XPS peak can be de-convoluted into two distinct peaks, respectively corresponding to the lattice oxygen (O_L) and oxygen vacancies (O_V), demonstrating the presence of oxygen vacancies.

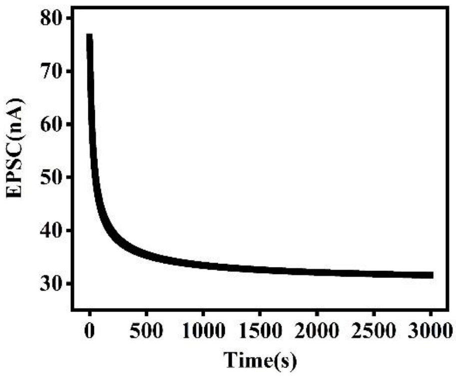

Fig. S4 Retention characteristics of NNO/n-GaN heterostructure after stimulation with 50 light pulses of intensity 2.7 μW/mm^2.

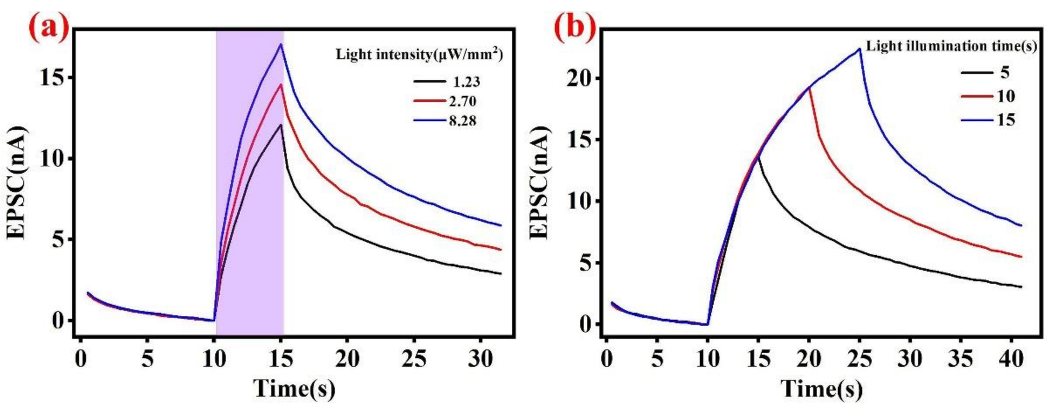

Fig. S5 Current-time (I-t) characteristics under optical pulses with (a) different intensities and (b) different illuminating times of NNO/n-GaN heterostructure. Notably, variable light intensities and light retention times can also be used to perform STM, LTM, and STM-LTM conversion. Higher light intensity or longer retention time will induce higher photocurrent response, and the photocurrent will also be maintained at a higher level after stimulation of light pulse, resulting in the STM-LTM conversion [1].

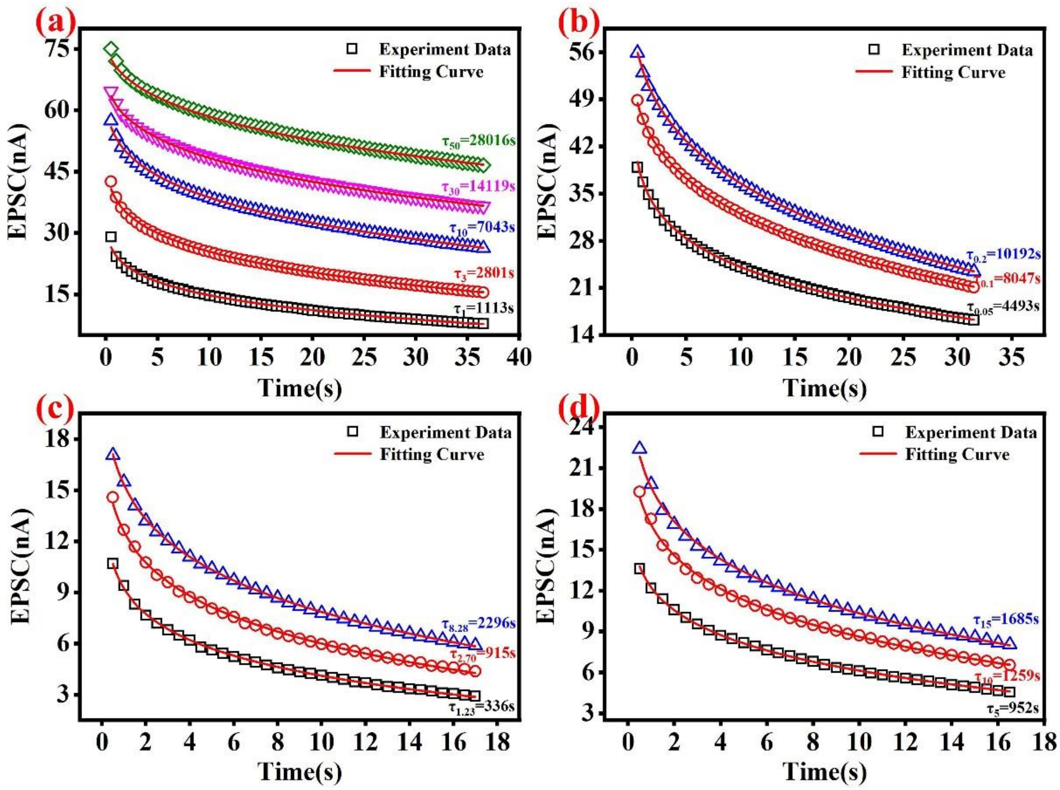

Fig. S6 Current decay and fitting results under different optical pulse numbers (a), frequencies (b), light intensities (c) and illuminating times (d) of NNO/n-GaN heterostructure. With the increase of pulse number, light frequency, light intensity and light retention time, the value of characteristic time τ increases, which is strong evidence for the transition from STM to LTM [2].

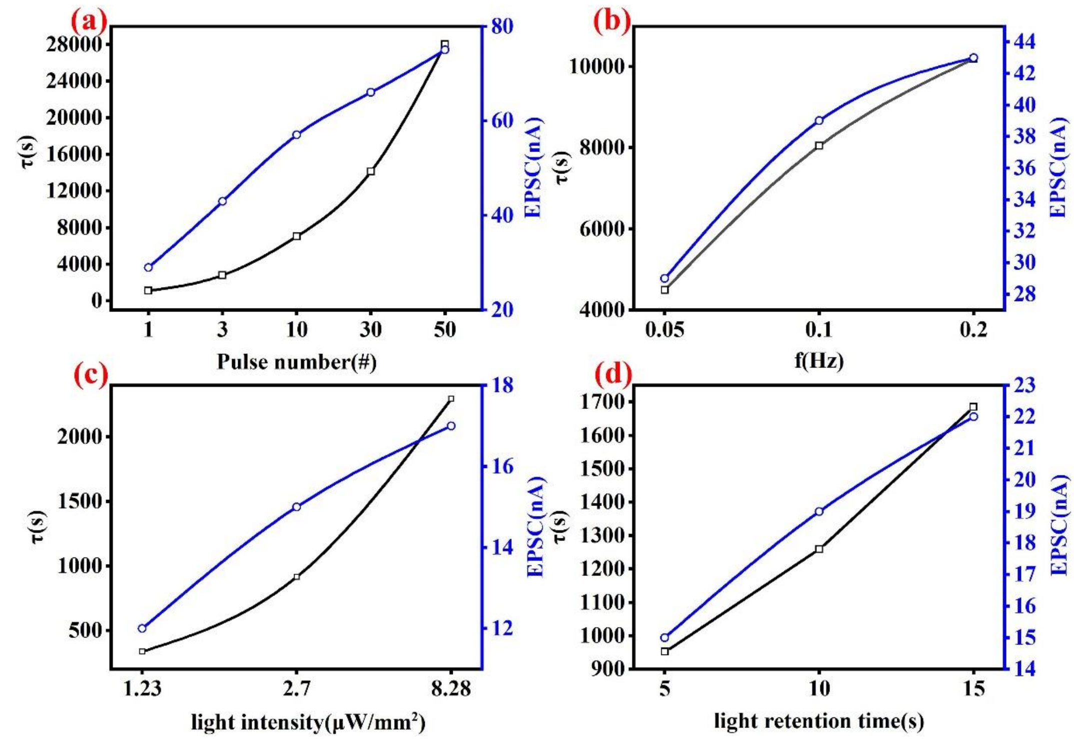

Fig. S7 τ and EPSC as a function of pulse number (a), frequencies (b), light intensities (c) and illuminating times (d) of NNO/n-GaN heterostructure.

References

[1] D. C. Hu, R Yang, L Jiang, et al., "Memristive Synapses with Photoelectric Plasticity Realized in ZnO_{1-x}/AlO_y Heterojunction," ACS Appl. Mater. Inter. **10**, 6463(2018).

[2] K Wang, S Dai, Y Zhao, et al., "Light-Stimulated Synaptic Transistors Fabricated by a Facile Solution Process Based on Inorganic Perovskite Quantum Dots and Organic Semiconductors," Small **15**, 1900010 (2019).