

Supporting Information

Light-stimulated artificial synapses based on Si-doped GaN thin films

Youhan Mo, Bingcheng Luo, Huijuan Dong, Boyu Hou*

MOE Key Laboratory of Material Physics and Chemistry under Extraordinary, School
of Physical Science and Technology, Northwestern Polytechnical University, Xi'an,
Shaanxi, 710072, China

*Corresponding author, Electronic mail: luobingcheng@nwpu.edu.cn

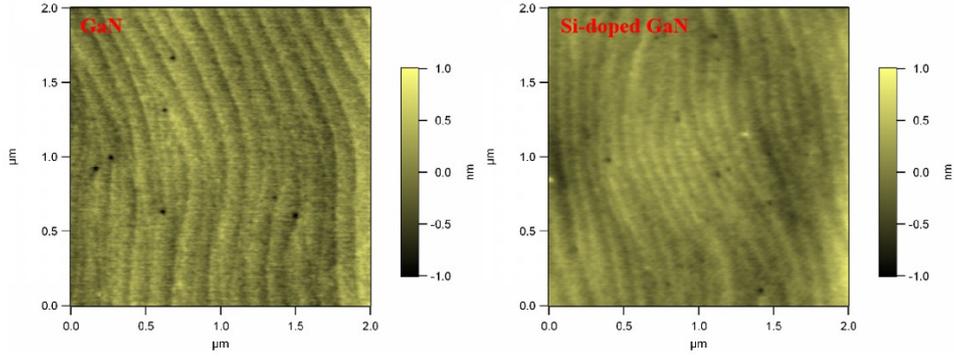


Fig. S1 AFM images for GaN and Si-doped GaN thin films. AFM images reveal a smooth surface with observable atomic steps, and the root-mean-square (RMS) values of surface roughness measured by Igor Pro software are less than 0.2 nm for both samples.

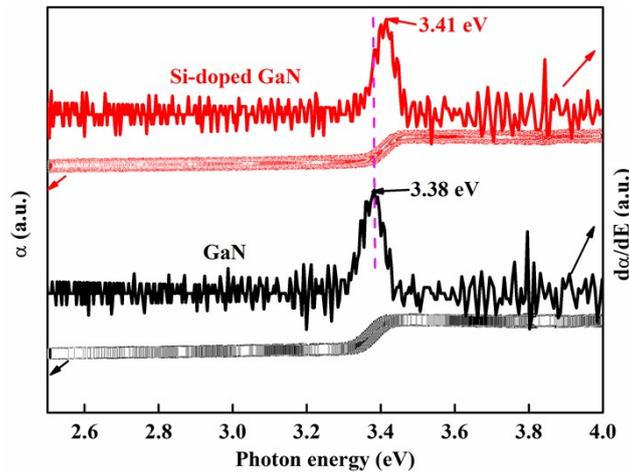


Fig. S2 Optical absorption spectra and the corresponding first-derivative for GaN and Si-doped GaN thin films. Due to the direct-bandgap character of GaN thin films, the first derivative of absorption with respect to photon energy E can be used to determine the bandgap E_g , wherein the position of maximum in the derivative spectrum corresponds to the E_g .¹ The E_g values are determined to be about 3.38 eV and 3.41 eV for GaN and Si-doped GaN thin films, respectively. A larger E_g value for Si-doped GaN thin film can be attributed to the Burstein-Moss effect.²

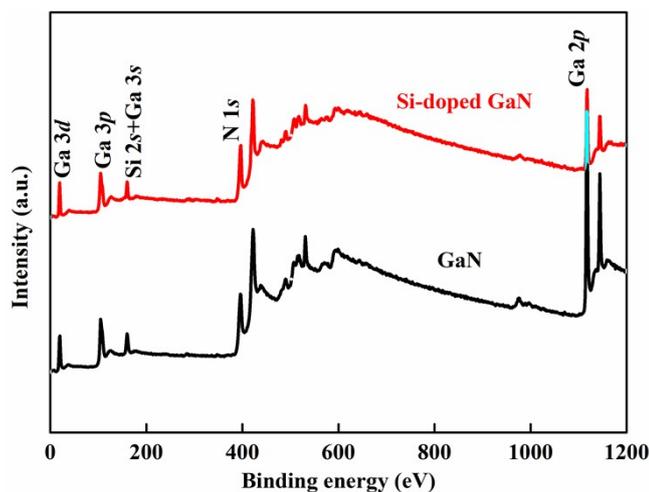


Fig. S3 Full-scan XPS spectra for GaN and Si-doped GaN thin films.

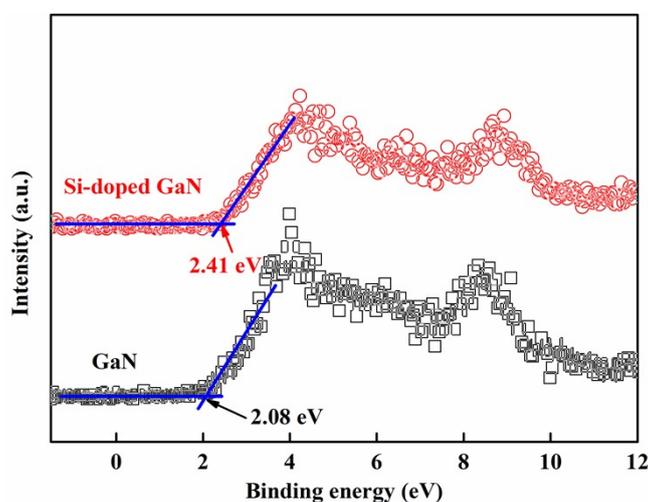


Fig. S4 Valence band spectra for GaN and Si-doped GaN thin films. The difference ($E_F - E_{VBM}$) could be determined to be about 2.08 eV and 2.41 eV for GaN and Si-doped GaN thin films, respectively. Combining the bandgap E_g values, it is found that the position of the Fermi level is above the mid-gap for both samples, meaning the n -type conduction. Also, the Fermi level moves towards conduction band when doping Si, reflecting the increased carriers.³

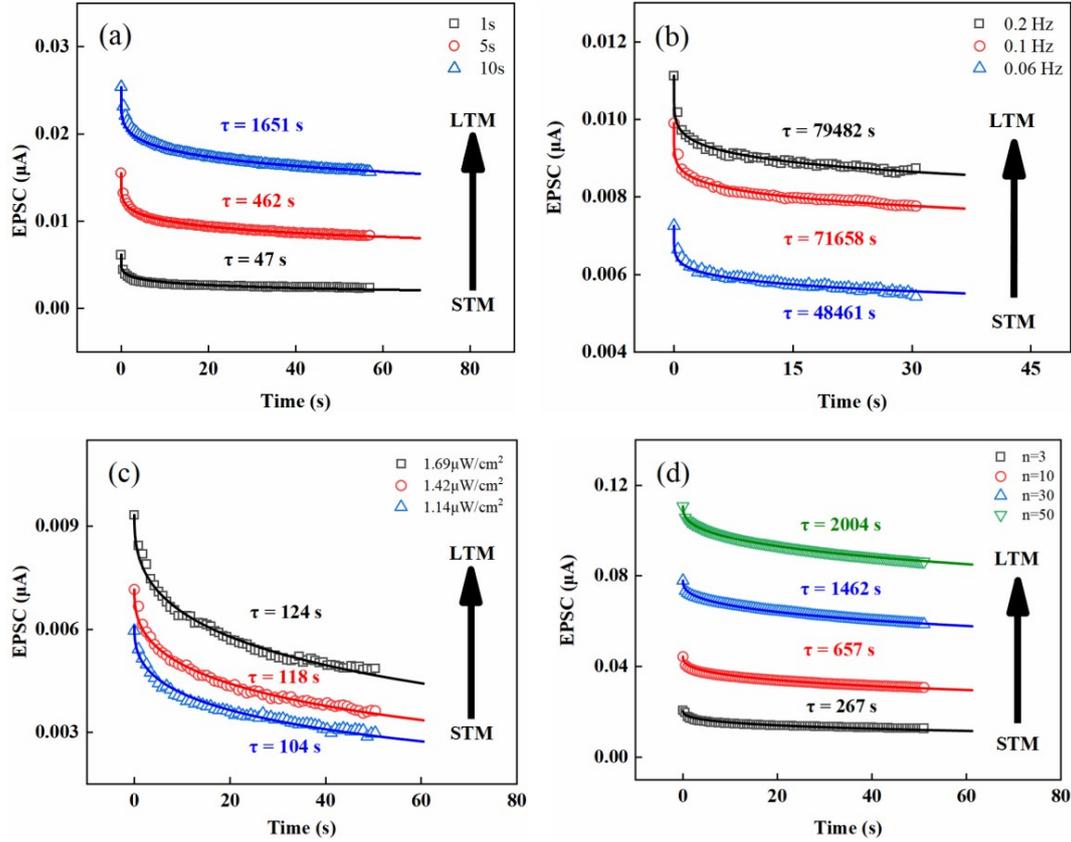


Fig. S5 The decay time constant of STM-to-LTM transition induced by (a) lighting duration, (b) frequency, (c) intensity, (d) pulse number. The current attenuation part of the STM-to-LTM transition is shown in the Figure S5, and the experimental data are fitted by the stretched exponential function mentioned in the text. It can be seen from the fitting results that the characteristic time τ is positively correlated with lighting duration, frequency, intensity and pulse number, which further confirm the transition from STM to LTM.

References

- 1 B. C. Luo, J. Zhang, J. Wang and P. X. Ran, *Ceram. Int.*, 2015, **41**, 2668-2672.
- 2 M. Feneberg, S. Osterburg, K. Lange, C. Lidig, B. Garke, R. Goldhahn, E. Richter, C. Netzel, M. D. Neumann, N. Esser, S. Fritze, H. Witte, J. Bläsing, A. Dadgar and A. Krost, *Phys. Rev. B*, 2014, **90**, 075203.
- 3 W. Zhou, J. Vavro, N. M. Nemes, J. E. Fischer, F. Borondics, K. Kamaras and D. B. Tanner, *Phys. Rev. B*, 2005, **71**, 205423.