PHOTO-FERROELECTRIC ALL-VAN DER WALLS NEUROMORPHIC DEVICE

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2D ferroelectric materials have attracted interest since their introduction to the van der Waals (vdW) family.[1] The vdW interfacial coupling capabilities ease their implementation into complex hybrid architectures challenging with standard thin film technology.[2] Here, I will demonstrate the non-volatile electrical and optical control of the ferroelectric polarization in all-vdW ferroelectric/semiconductor heterostructures.[3] The wavelength-dependent study unveils ferroelectric polarization control and decouples the mechanisms driven by photogenerated carriers for each material. The vdW Ferroelectric Field-effect transistors show On/Off ratios exceeding 10^7, large hysteresis memory windows, and multiple remanent states, sorting them as good artificial synapse candidates. Following, long-term potentiation/depression, and spike rate-dependent plasticity are shown using electrical control. Moreover, the synaptic functionalities were complemented by the unique dual optical and electrical control, enabling optically stimulated and optically assisted synaptic devices. We benchmark our device with a simulated artificial neural network and achieve an excellent accuracy level of 91%, close to the ideal synaptic case (96%). The combination of the Photo-Ferroelectric functionalities and the shown synaptic characteristics put all-VdW ferroelectric/semiconductor heterostructures on the roadmap for novel computing architectures.

References

[1] Qi, L., Ruan, S. & Zeng, Y. J. Advanced Materials vol. 33 (2021).
[2] Jin, T. et al. ACS Nano (2022) doi:10.1021/acsnano.2c07281.
[3] M. Soliman, et al., ACS Appl. Mater. Interfaces 2023, 15, 12, 15732–15744.Authors,

Figures

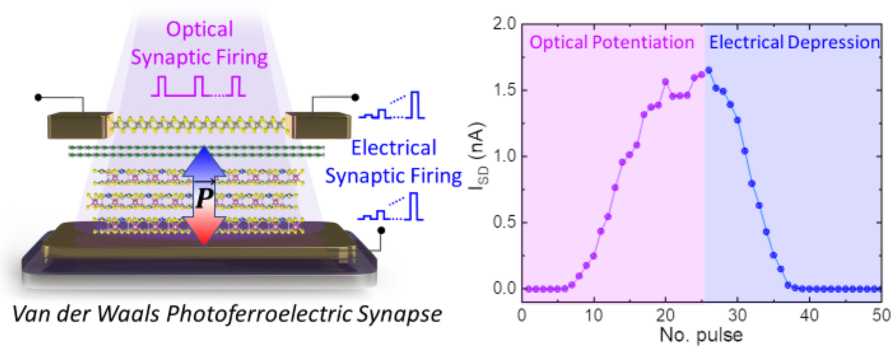

Figure 1: Left: schematic of the device.
Right: Light potentiation/Electrical depression Synaptic Plasticity.
(Adapted from [3])