# Supplementary information for programmable mixed-kernel based on MoTe$_2$/MoS$_2$ heterojunction for support vector machine learning

Xinyu Huang[1, *], Jiapeng Du[1, *], Langlang Xu[1, *], Lei Tong[2, †], Xiangxiang Yu[1, †], Lei Ye[1, 3, †]

[1] School of Integrated Circuits, Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology, Wuhan, China
[2] Department of Electronic Engineering, Materials Science and Technology Research Center, The Chinese University of Hong Kong, Hong Kong, China
[3] Yangtze Laboratory, Wuhan, China
* These authors contributed equally to this work.
† Corresponding authors. Email: leiye@hust.edu.cn (L. Y.); yuxx518@126.com (X. Y.); leitong@cuhk.edu.hk (L. T.)

# Supplementary notes

## 1. Device fabrication.

Few-layer $MoTe_2$/$MoS_2$ flakes were mechanically exfoliated from bulk crystals (from HQ Graphene). Suitable few-layer flakes with uniform surfaces and dimensions near 10 × 20 $\mu m^2$ were identified and selected. These flakes were then precisely assembled into a lateral heterostructure on a substrate using a PDMS-assisted (polydimethylsiloxane) deterministic transfer method. Subsequently, Cr/Au (5/50 nm) source/drain contacts were defined via ultraviolet photolithography and deposited by electron-beam evaporation. Finally, the sample was mounted and wire-bonded onto a 24-pin chip carrier.

## 2. Experimental setup.

For optoelectronic measurements, quasi-monochromatic light was generated by passing a continuous-wave (CW) laser beam (Changjiang Soton, Model: SC-PRO) through a controller-driven monochromator. The light was then focused onto the device via a 10× microscope objective. A commercial spectrometer (Ocean Optics, HR-4VN400-5) was used to measure the reference spectrum information. The gate voltage was applied using a source measure unit (National Instruments, PXIe-4141/4142), which simultaneously recorded the output current. Standard electrical characterization was conducted using a semiconductor device analyzer (Keysight B1500A) integrated with a Lake Shore probe station. All measurements were performed at room temperature under ambient conditions.

## Supplementary figures

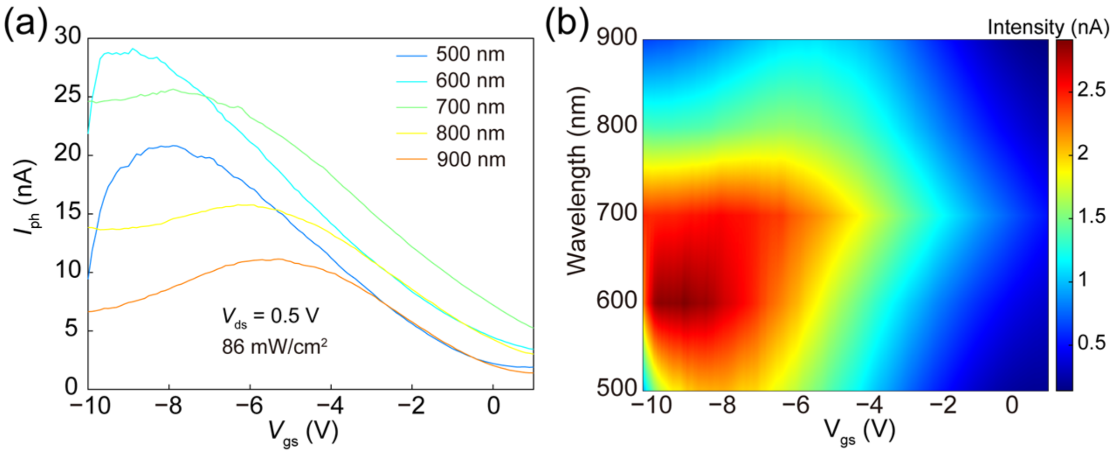

**Fig. S1. (a)** Photocurrent as a function of gate voltage under illumination at a fixed power density of 86 mW/cm$^2$ for various wavelengths. **(b)** 2D pseudocolor plot of the photocurrent at 46 mW/cm$^2$ as a function of gate voltage and wavelength, visualizing the systematic evolution of the photocurrent peak.

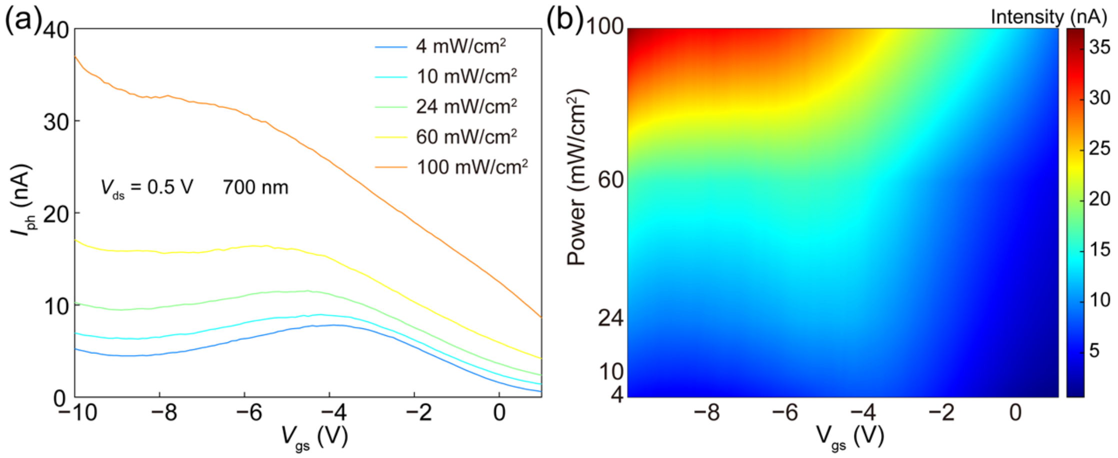

**Fig. S2. (a)** Photocurrent as a function of gate voltage under illumination at a fixed wavelength of 700 nm for various optical power densities. **(b)** 2D pseudocolor plot of the photocurrent at 700 nm as a function of gate voltage and optical power, visualizing the systematic evolution of the photocurrent peak.

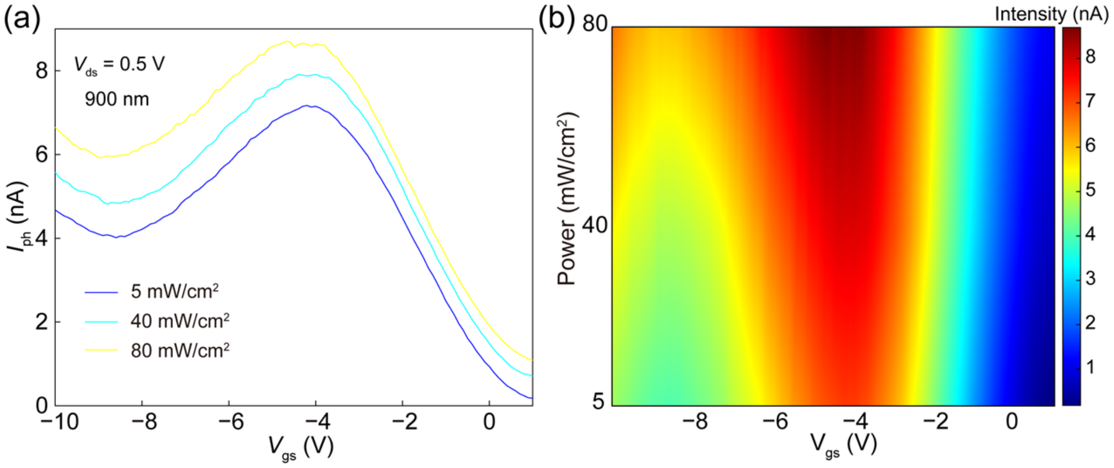

**Fig. S3. (a)** Photocurrent as a function of gate voltage under illumination at a fixed wavelength of 900 nm for various optical power densities. **(b)** 2D pseudocolor plot of the photocurrent at 900 nm as a function of gate voltage and optical power, visualizing the systematic evolution of the photocurrent peak.