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• **Supplementary File** •

Ultra-low Power MoS_2 Optoelectronic Synapse with Wavelength Sensitivity for Color Target Recognition

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† Bo Wei and Yabo Chen have the same contribution to this work.

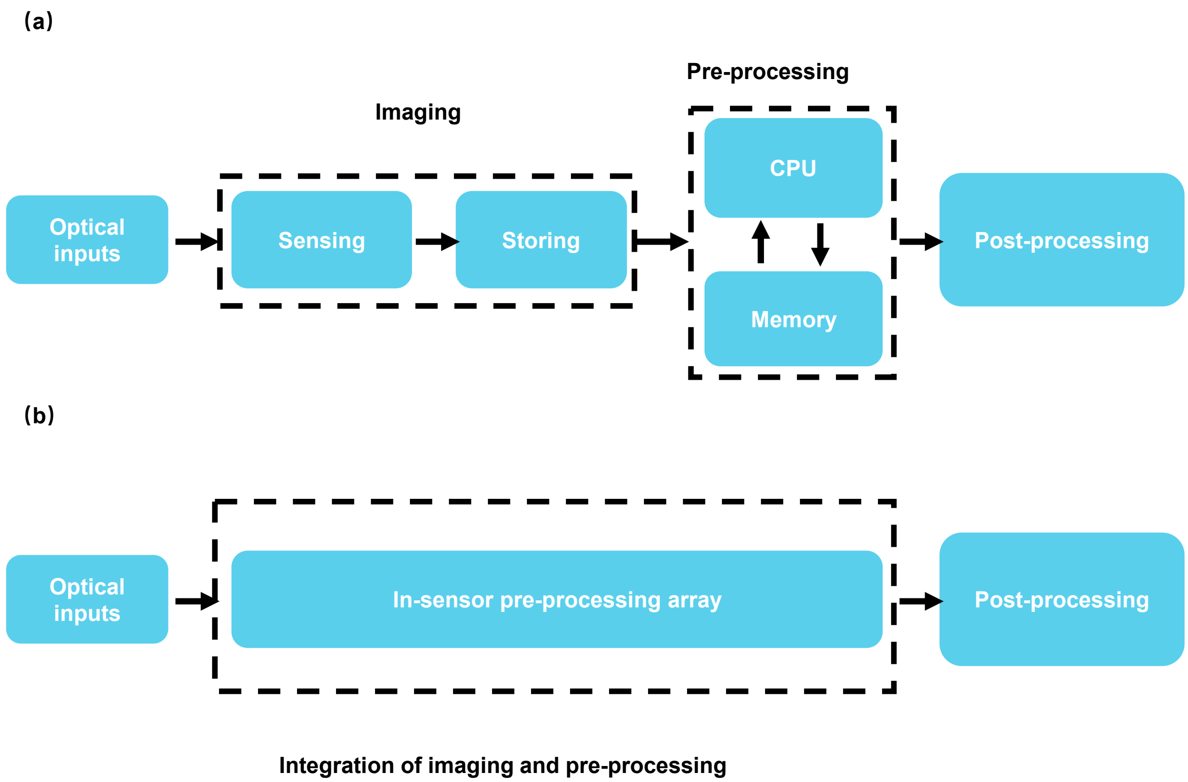

Figure 1 Block diagram showing the sequence of the image recognition using (a) conventional artifical vision system and (b) neuromorphic vision system. For conventional artificial vision systems, the sensing array responds to incident light (optical inputs) and generates photocurrent proportional to light intensity. All the data measured by the sensor array are then converted into digital signals and stored for frame-based image recognition. Then the stored raw image data are sent to the pre-processing module. The pre-processed image is sent to post-processing unit (e.g., GPU) for tasks such as target recognition. On the contrary, neuromorphic vision system integrates imaging and pre-processing funciton into an optoelectronic synapse. Therefore, there is no need for massive data storage, communication, and iterative data processing as required in traditional artificial vision system to obtain pre-processed images, thus reducing latency and improving efficiency.

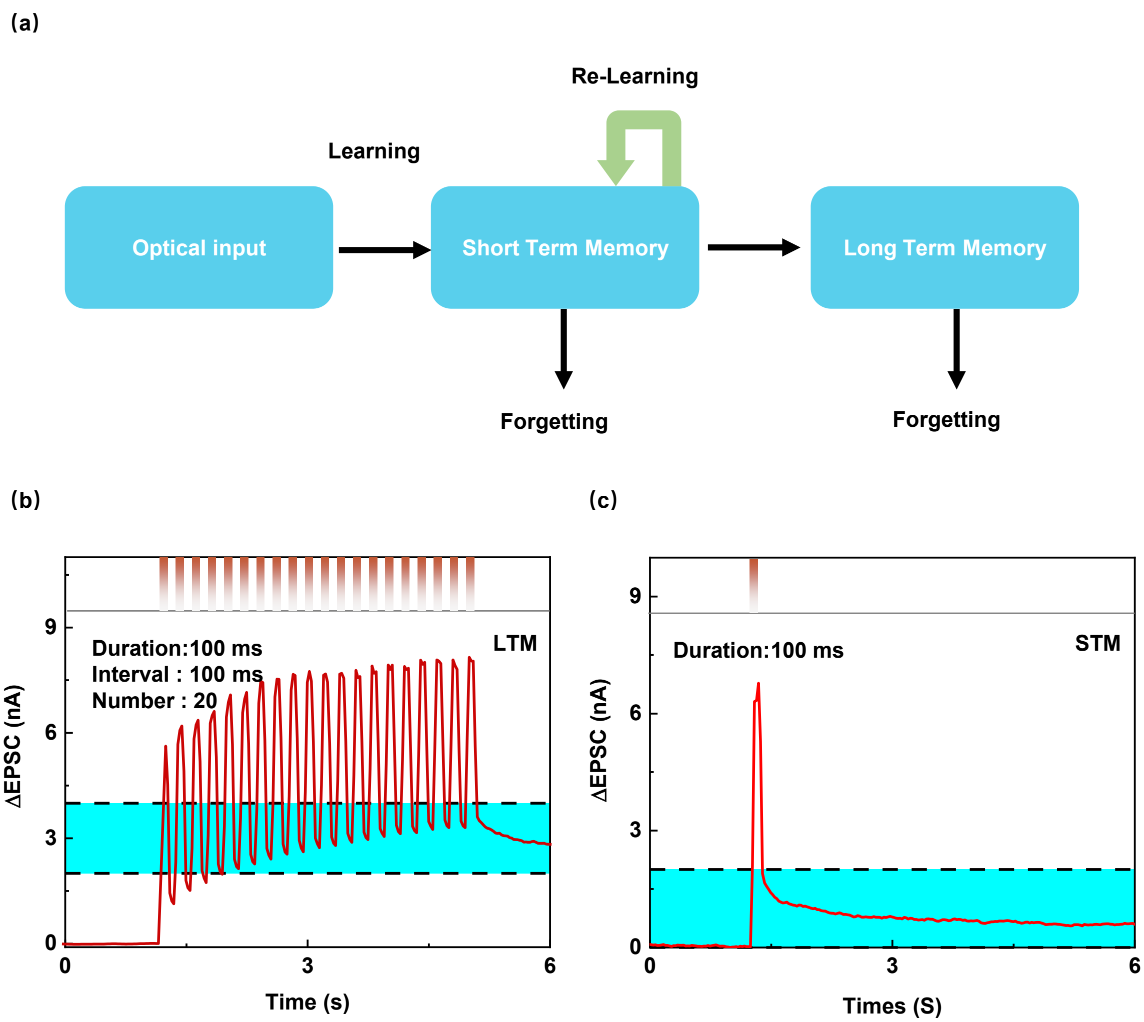

Figure 2 MoS_2 optoelectronic synapse based imitation of psychological functions. (a)Schematic illustration of learning and forgetting model of human brain. According to the model, the optical input received by learning is converted into short-term memory (STM) and stored from seconds to minutes. If frequent maintenance (relearning) is provided, then it can cause transition from STM to LTM which last from minutes to years. The ΔEPSC triggered by (b) 20 times of learning-forgetting-relaring process and (c) 1 leanring-forgetting process. It is evident that after 20 times learning and relearning processes, the ΔEPSC of the optoelectronic synapse reaches a higher level, implying that a transition from STM to LTM is realized.

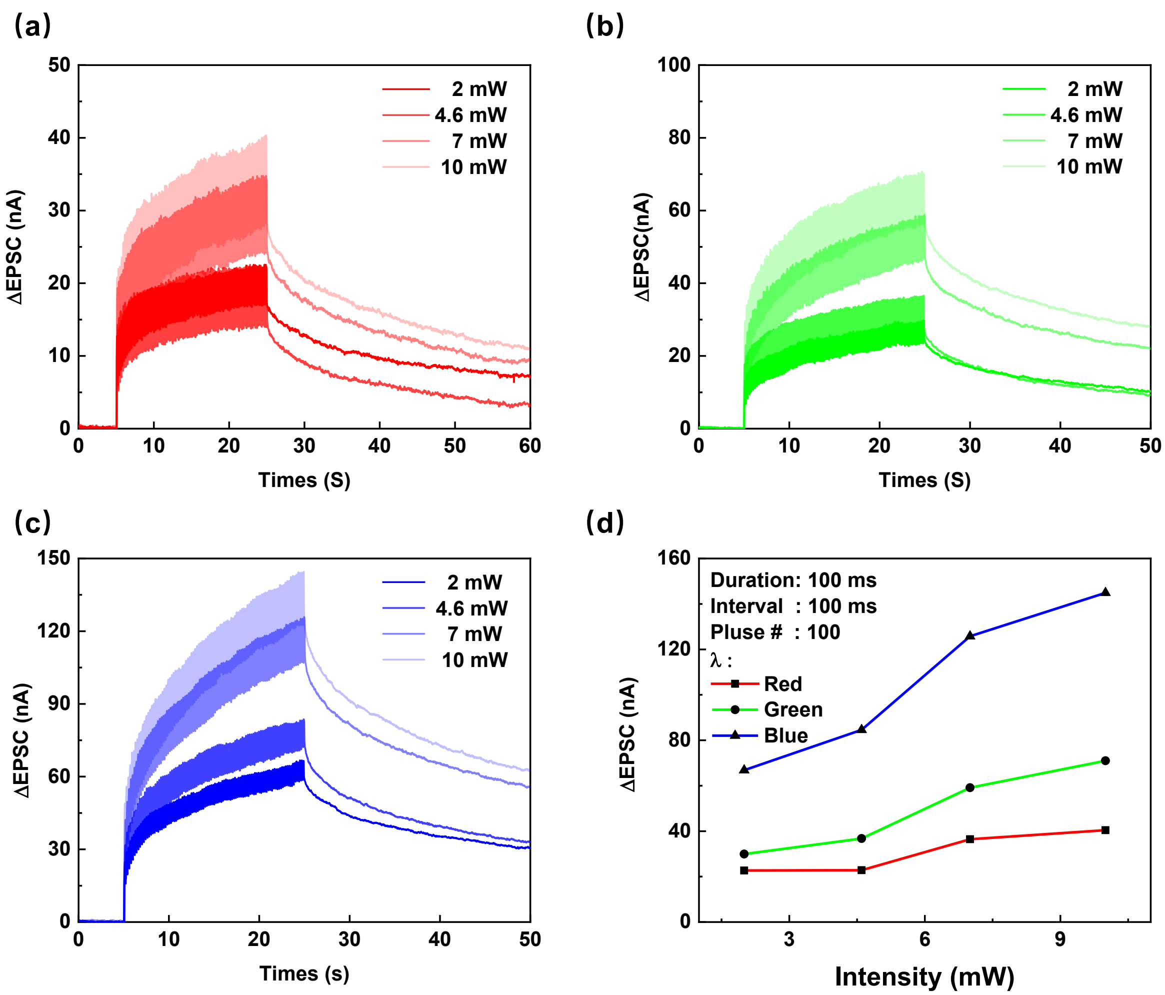

Figure 3 ΔEPSC responses under different light intensities induced by the (a)blue light, (b)green light and (c)blue ligh. The pulse number and duration time and interval time were fixed at 100 and 100 ms and 100 ms, respectively. The linear dependence of the maximum ΔEPSC on the light intensity under the blue, green and red light illumination were drawn in (d).

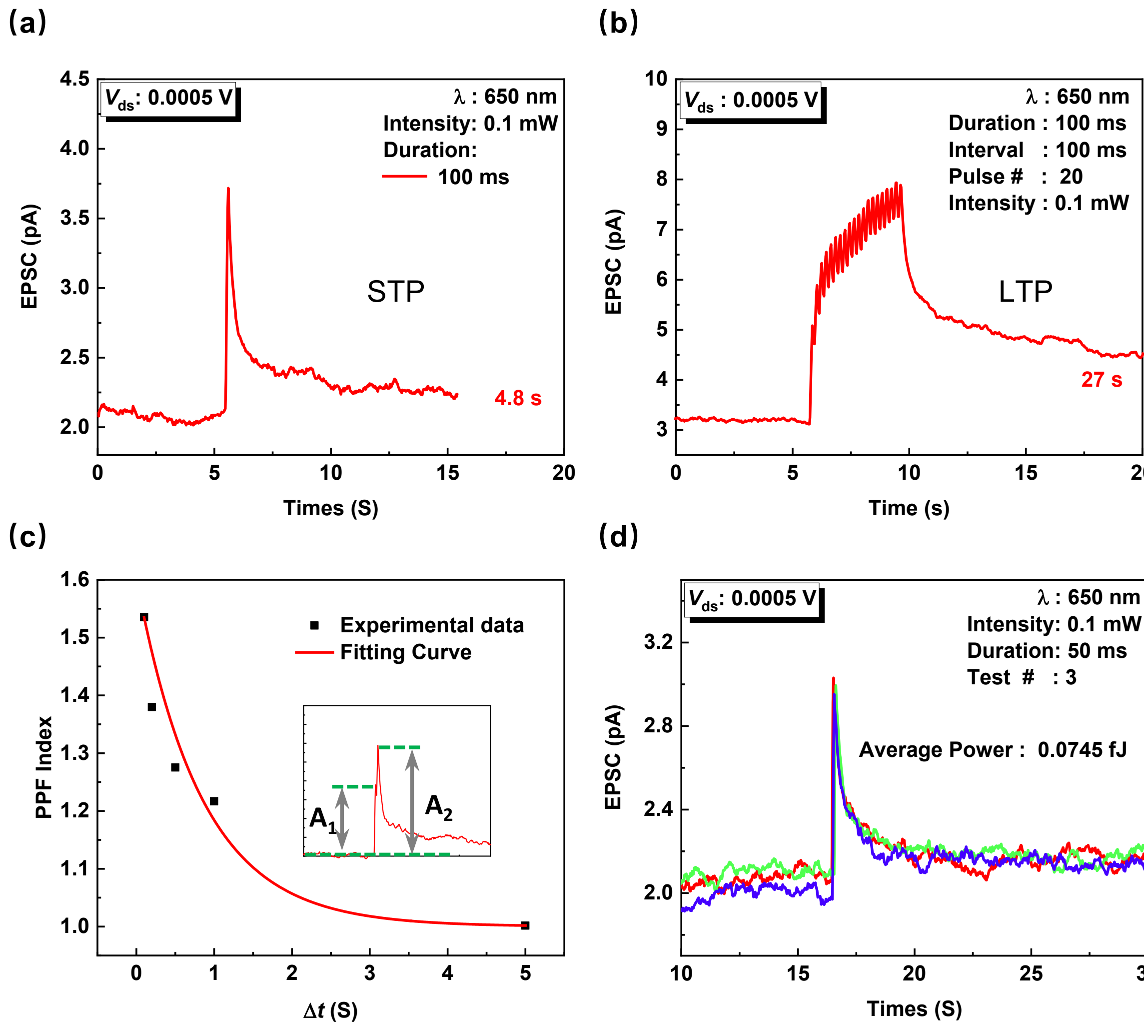

Figure 4 Low power consumption of MoS_2 optoelectronic synapse. A smaller EPSC triggered by possible small voltage and short duration and weak light stimuli. Synaptic plasticity of (a) EPSC and (b) LTP and (c) PPF were obtained when V_{ds} was set to 0.0005 V, for which the calculated energy consumption was 0.1875 fJ. A shorter pulse width of 50 ms was then chosen to stimulate the device 3 times, and significant EPSC behavior was obtained likewise. Therefore, we achieved a minimum power consumption of 0.0745 fJ/spike, which is significantly lower than the existing optoelectronic synapses and biology synapses.