Supporting information

Organic Neuromorphic Vision Devices with Multilevel Memory for Palmprint Identification

Chenxi Liu[1,2], Yongfeng Gu[3], Yongjie Ren[3], Mingyi Ding[1,2*], Tao Deng[4*], Harald Fuchs[5], Deyang Ji[1,2*] and Wenping Hu[2,6]

[1]Tianjin Key Laboratory of Molecular Optoelectronic Sciences, Department of Chemistry, Institute of Molecular Aggregation Science, Tianjin University, Tianjin 300072, China

[2]Key Laboratory of Organic Integrated Circuit, Ministry of Education, Tianjin University, Tianjin 300072, China

[3]National Key Laboratory of Precision Testing Technology and Instruments, Tianjin University

[4]School of Electronic and Information Engineering, Beijing Jiaotong University, Beijing 100044, China.

[5]Physikalisches Institut and Center for Nanotechnology (CeNTech), Westfälische Wilhelms-Universität Münster, Germany

[6]Tianjin Key Laboratory of Molecular Optoelectronic Sciences, Department of Chemistry, School of Science, Tianjin University, 300072, China

* Corresponding author E-mail address: jideyang@tju.edu.cn; dengtao@bjtu.edu.cn

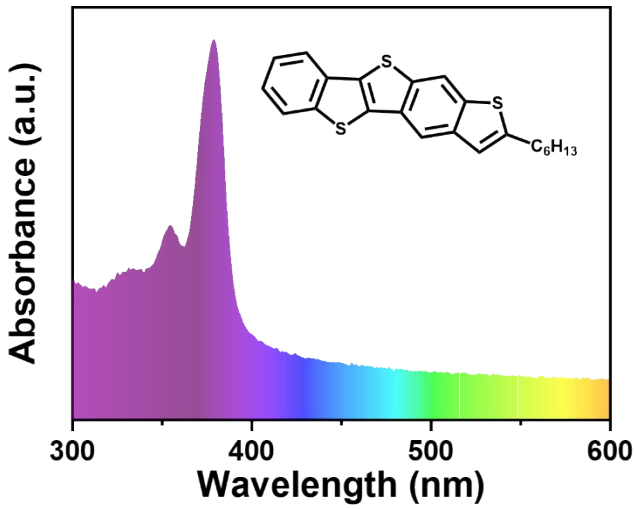

Fig. S1 UV-vis absorption spectra of BTBTT6-syn film; inset: molecular structure diagram of BTBTT6-syn.

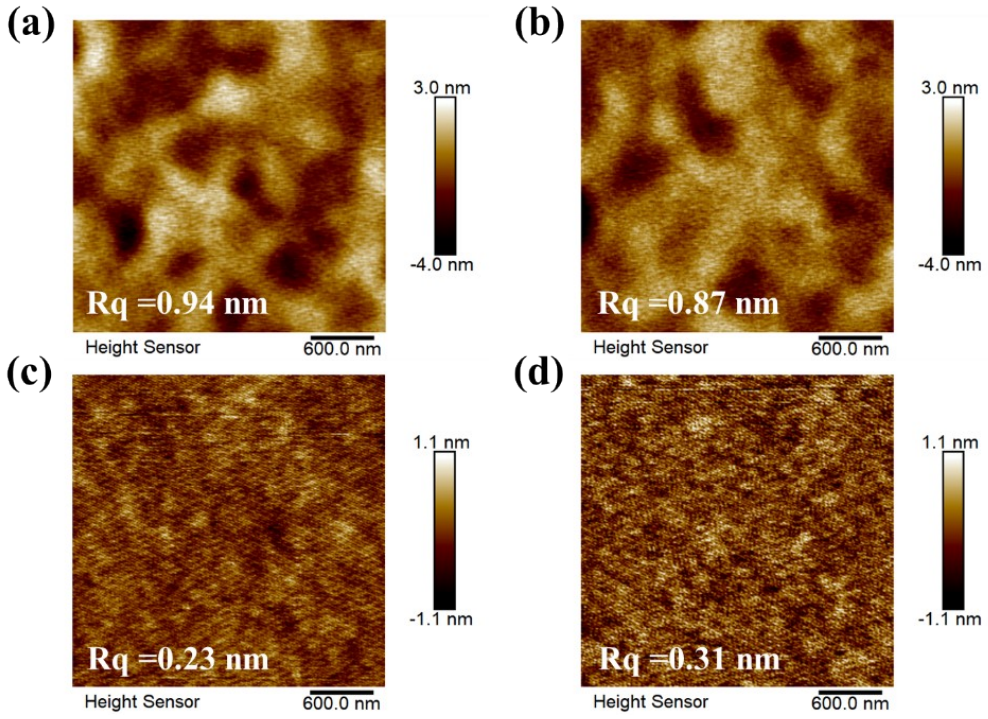

Fig. S2 AFM images of (a) PVP, (b) PPO, (c) PVP/HfO_2, and (d) PPO/HfO_2.

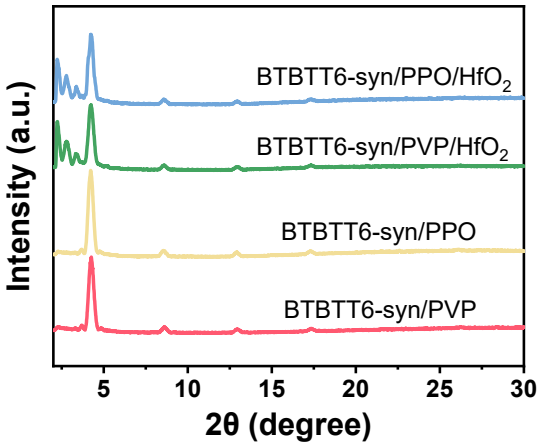

Fig. S3 XRD patterns of vacuum-deposited BTBTT6-syn on PVP, PPO, PVP/HfO_2, and PPO/HfO_2.

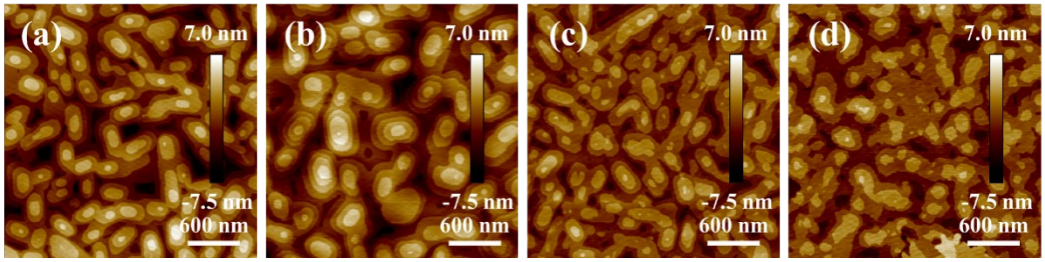

Fig. S4 AFM images of BTBTT6-syn films grown on (a) PVP, (b) PPO, (c) PVP/HfO_2, and (d) PPO/HfO_2 dielectric layers.

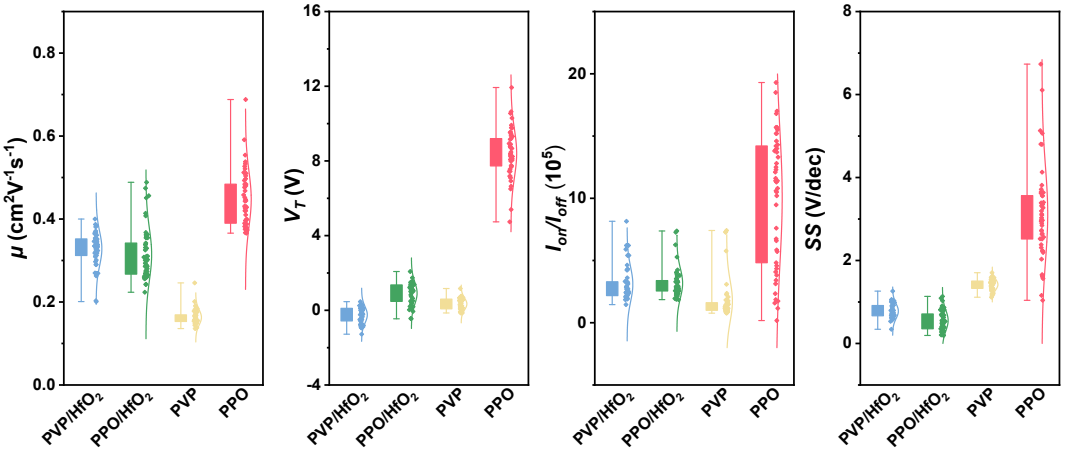

Fig. S5 Statistical analysis of electrical characteristics of 49 devices.

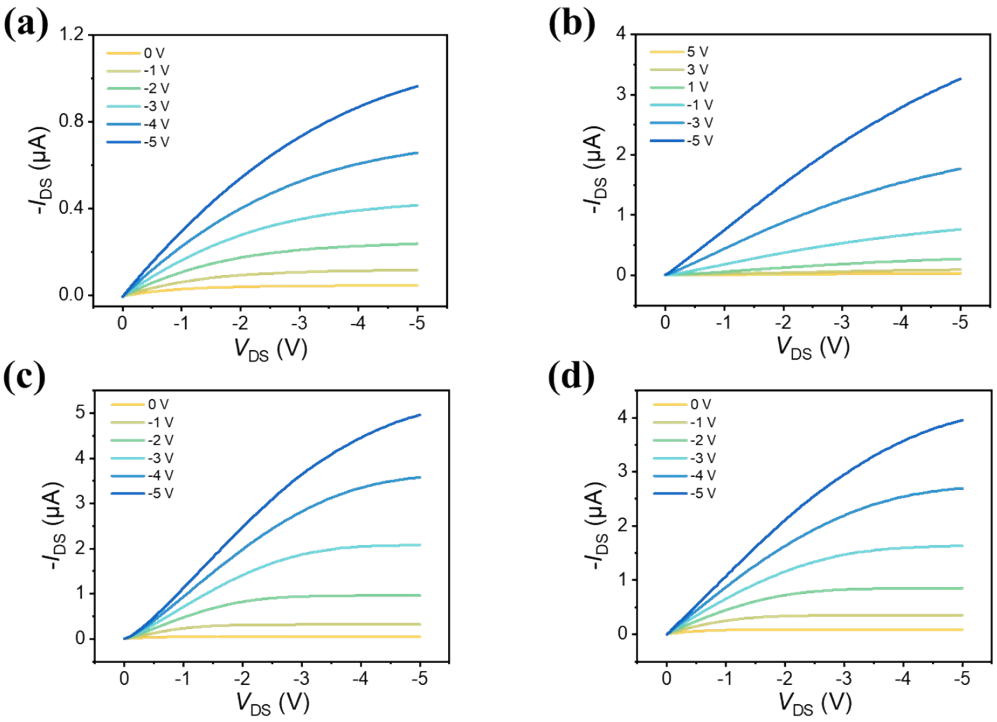

Fig. S6 Output curves of the devices with (a) PVP, (b) PPO, (c) PVP/HfO_2, and (d) PPO/HfO_2 as the dielectric layer.

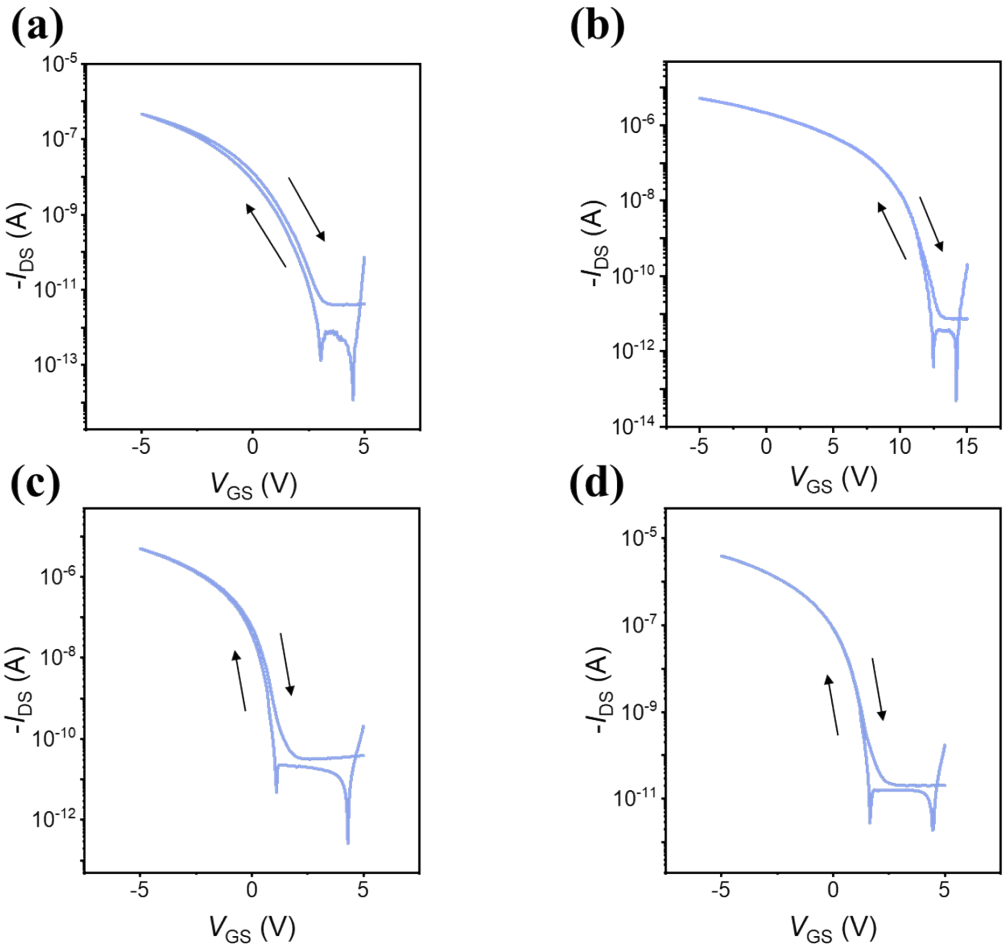

Fig. S7 Transfer characteristics (forward and reverse sweeps) with (a) PVP, (b) PPO, (c) PVP/HfO_2 and (d) PPO/HfO_2 as the dielectric layers.

The photosensitivity (P) and photoresponsivity (R) and detectivity (D*) are key parameters for measuring the performance of phototransistors.[1]

$$P = I_{\text{illumination}} / I_{\text{dark}} \tag{1}$$

$$R = I_{\text{illumination}} (P_{\text{i}} S)^{-1} \tag{2}$$

$$D^* = RS^{1/2} (2eI_{dark})^{-1/2} \tag{3}$$

where P_{i} is the illumination intensity and S is the illuminated area.

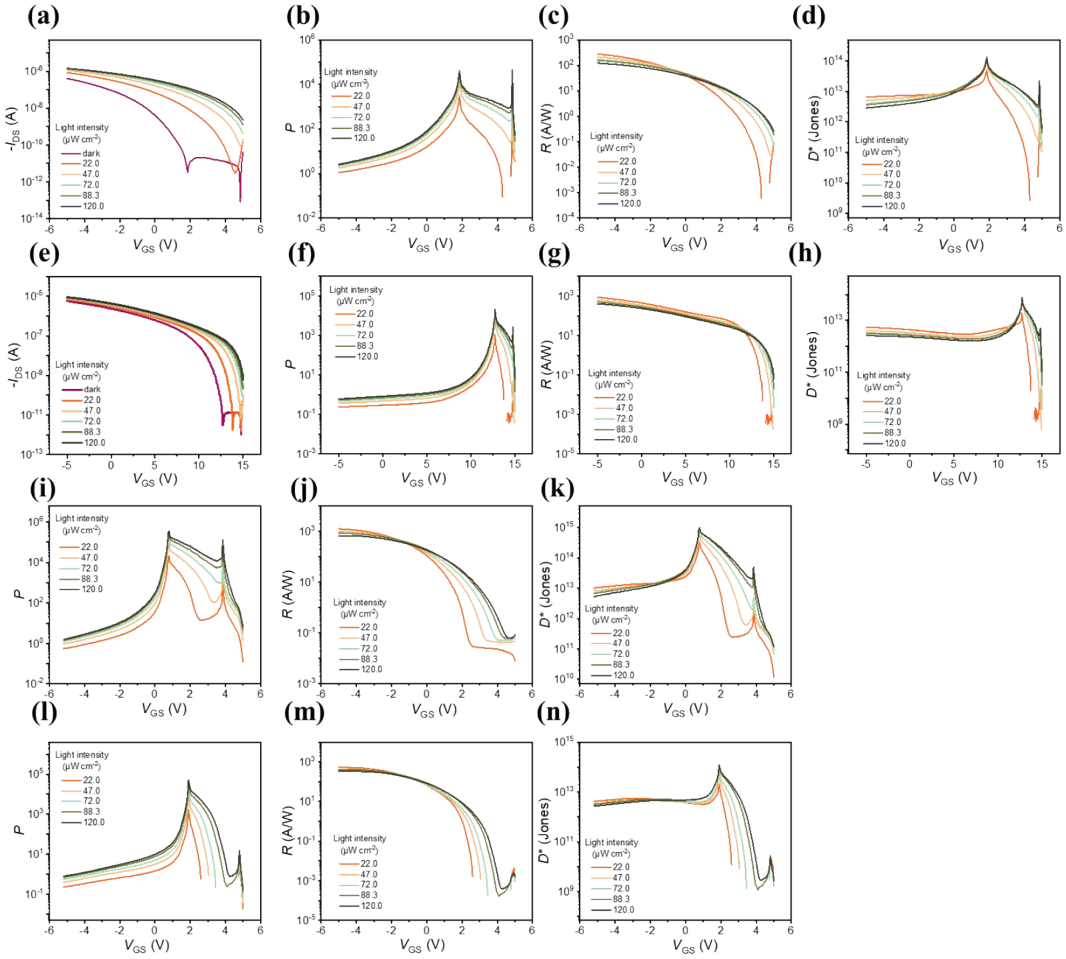

Fig. S8 Transfer curves of (a) PVP-based and (e) PPO-based OPTs under different illumination intensities. *P* values of (b) PVP-based, (f) PPO-based, (i) PVP/HfO_2-based, and (l) PPO/HfO_2-based OPTs under different illumination intensities. *R* values of (c) PVP-based, (g) PPO-based, (j) PVP/HfO_2-based, and (m) PPO/HfO_2-based OPTs under different illumination intensities. D^* values of (d) PVP-based, (h) PPO-based, (k) PVP/HfO_2-based, and (n) PPO/HfO_2-based OPTs under different illumination intensities.

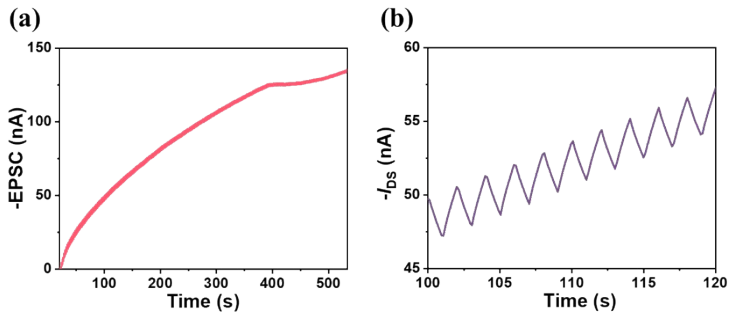

Fig. S9 (a) Multilevel memory of PVP/HfO_2 by multiple light pulses (365 nm, 88.3 μW/cm^2, t_{spike} = 1 s, $t_{interval}$ = 1 s), showing 256 storage states. (b) The corresponding magnified curves of Fig. S9a.

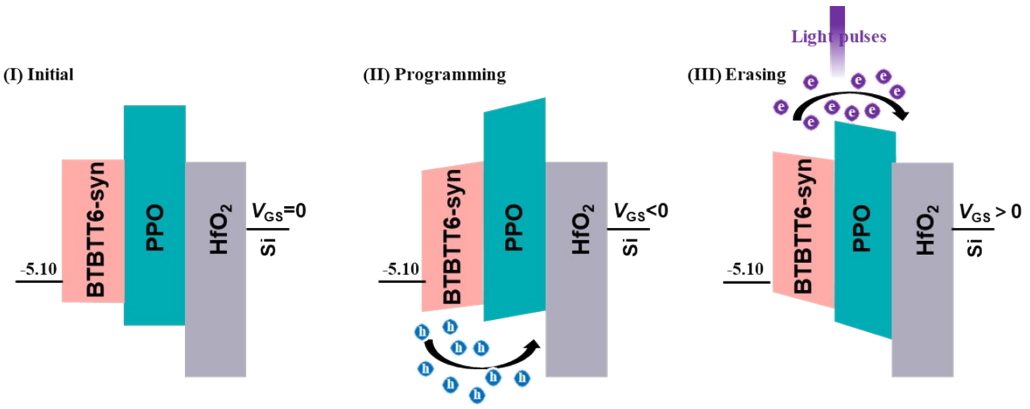

Fig. S10 Working mechanism of electrical-programmed state and light-erased state in the PPO/HfO_2-based device.

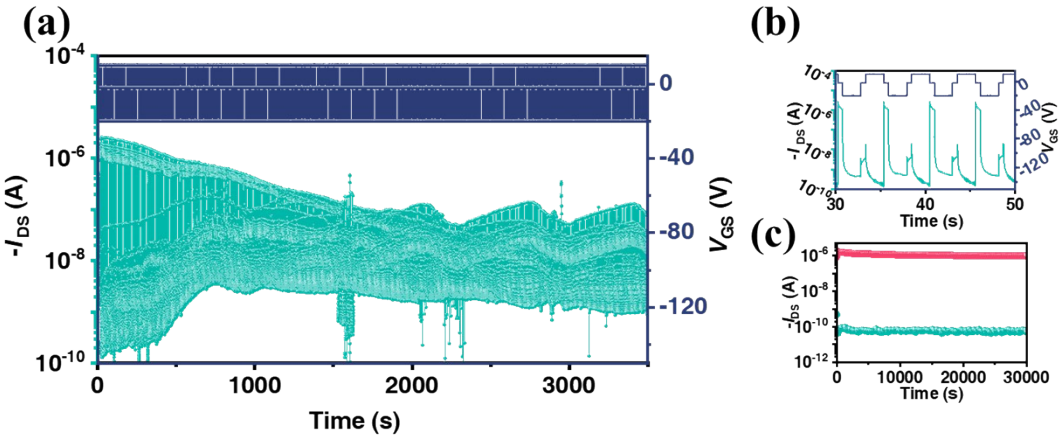

Fig. S11 (a) Endurance characteristics of the PPO/HfO_2-based device, change in off- and on- current over 700 P/E cycles. (b) Detailed curves of the endurance characteristics of the PPO/HfO_2-based device, programmed by V_{GS} = -20 V, t_{spike} = 2 s, erased by a light pulse (365 nm, t_{spike}= 2 s) with V_{GS} = 10 V. (c) Retention characteristic of program state and erase state for PPO/HfO_2-based device.

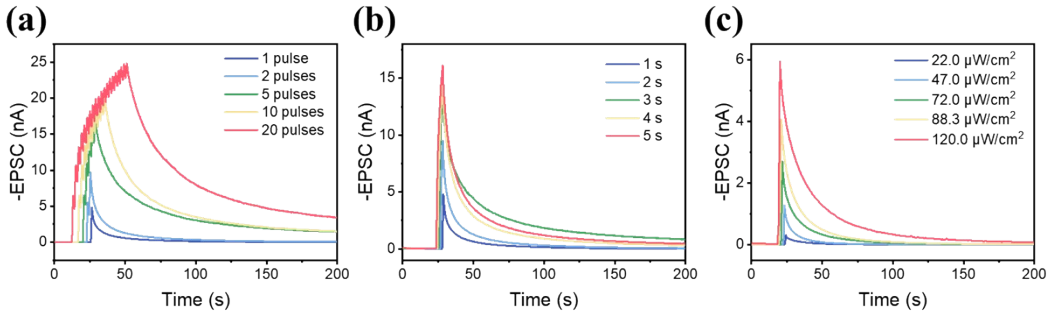

Fig. S12 The relationship between EPSC of PVP/HfO_2-based device and (a) light pulse number (b) light pulse width (c) light pulse intensity.

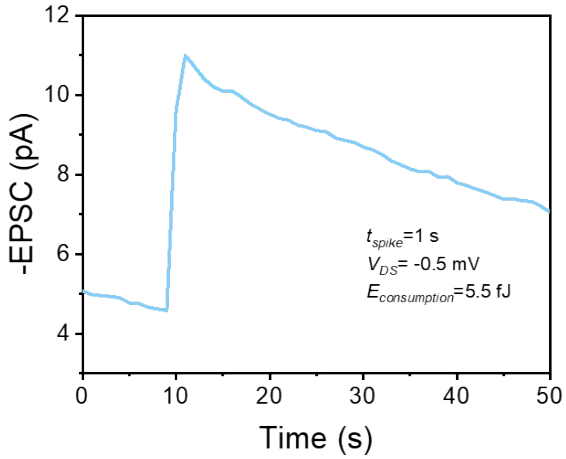

Fig. S13 The energy consumption of PVP/HfO_2 triggered by light pulses (V_{DS} = -0.5 mV, t_{spike} = 1 s).

Fig. S14 Preview of 85 palmprint images used in this work, sourced from the CASIA-Palmprint database. These images were randomly selected from 5 out of 312 participants, with specific IDs and counts as follows: ID 0003 (16 images), ID 0010 (16 images), ID 0100 (16 images), ID 0265 (20 images), and ID 0305 (17 images).

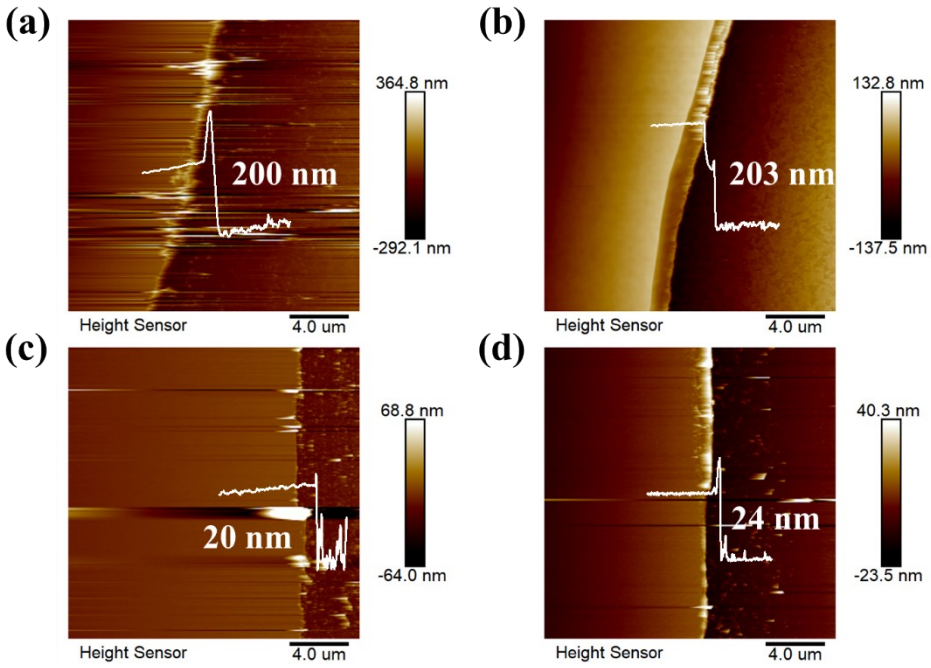

Fig. S15 The film thickness of (a) PVP spin-coated on ITO, (b) PPO spin-coated on ITO, (c) PVP spin-coated on HfO_2, and (d) PPO spin-coated on HfO_2 dielectric layer.

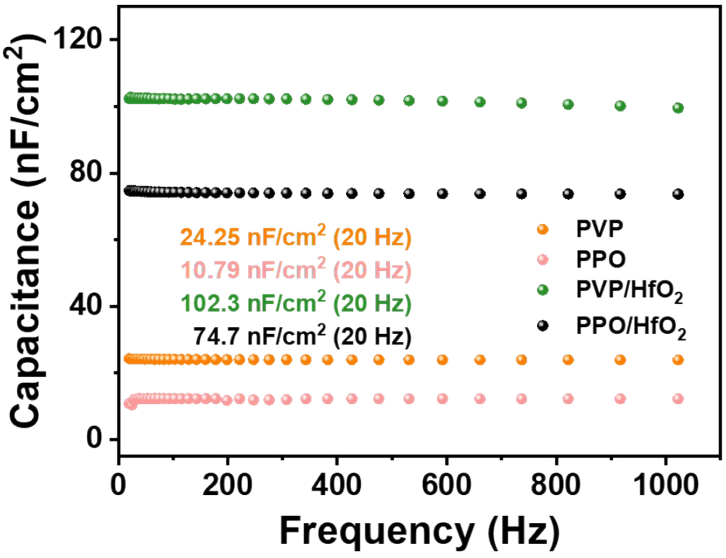

Fig. S16 Capacitance characteristic curves of different dielectric layer from 20-10^3 Hz. To measure the capacitance characteristics, 100-nm-thick silver films were deposited as electrodes with an area of 4 mm^2 on different dielectric layers.