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Supplementary Information

Dual-Mode Devices Integrating Photodetection and Optoelectronic Synaptic Plasticity Based on $Pb(Zr,Ti)O_3$ Films

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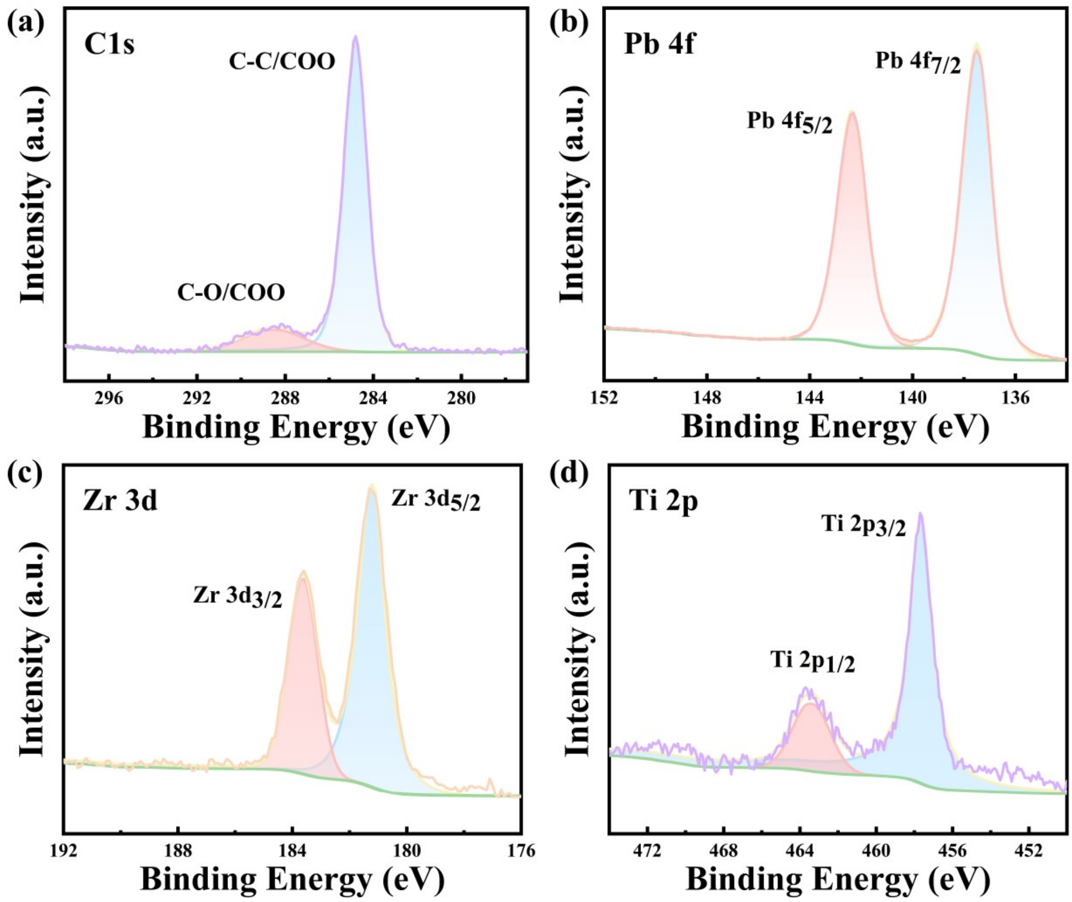

Fig.S1 XPS scans of PZT films deposited on ITO substrates. The XPS spectra show the core electrons of (a) C 1s, (b) Pb 4f, (c) Zr 3d, and (d) Ti 2p.

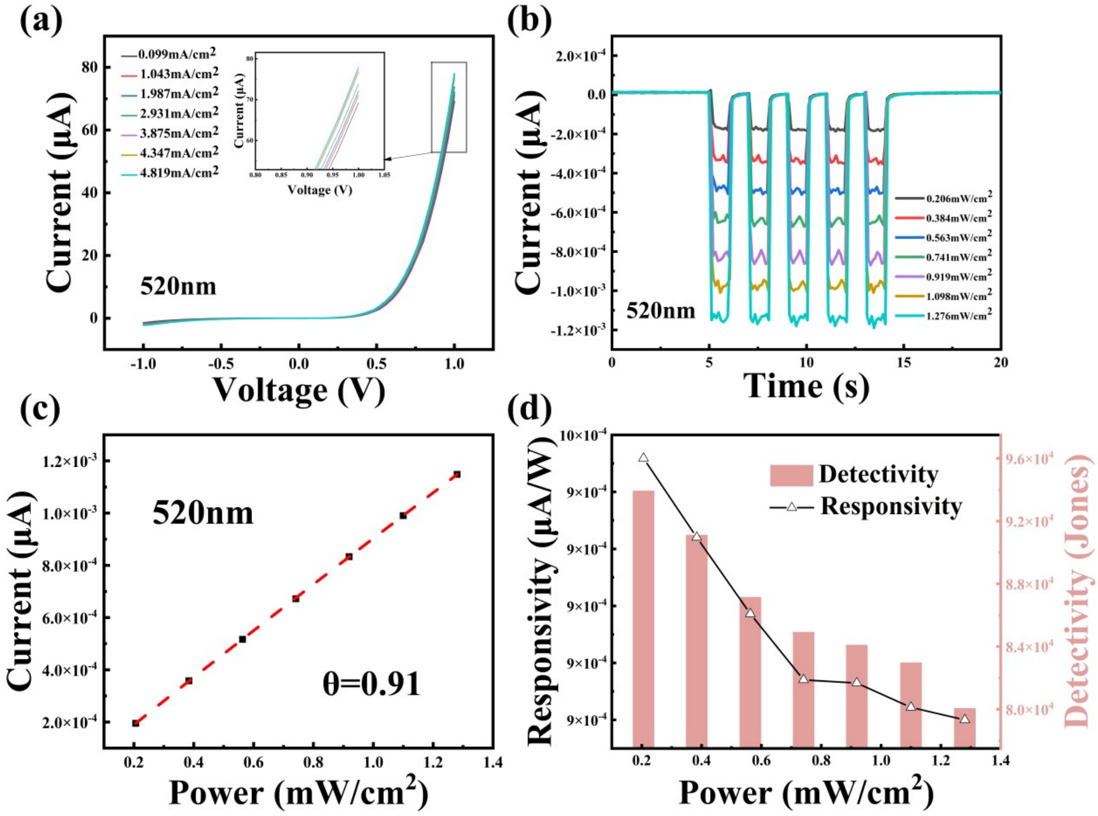

Fig.S2 Photovoltaic performance characterisation of ITO/PZT/ITO devices under 520 nm illumination. (a) I-V curves measured at different laser powers. (b) Time-dependent optical response (I-T curves) at varying laser powers. (c) Relationship between photocurrent (Iph) and incident power (Pin), along with power-law fitting results. (e) Variation of responsivity and detection efficiency with incident power.

Table S1. Comparison of Performance Parameters between PZT-Based Photodetectors and Previously Reported BTO-Based Devices

Materials	**R_{res} (mA W^{-1})**	**D^* (Jones)**	**Detectable wavelength range (nm)**	**Ref.**
PS-ITO/BTO/ITO	~10^{-4}	~10^{5}	365-405	[26]
ITO/BTO/Ag	~10^{-4}	~10^{5}	405	[27]
Ag/BTO/Ag	6.1×10^{-4}	9.8×10^{4}	365	[28]
ITO/BTO/ITO	7.17×10^{-3}	378.8	365	[29]
ITO/PLZT/PLZTN/Ag	4.48×10^{-4}	7.15×10^{7}	405	[30]
ITO/PZT/ITO	3.57×10^{-2}	2.60×10^{6}	405-520	Our work

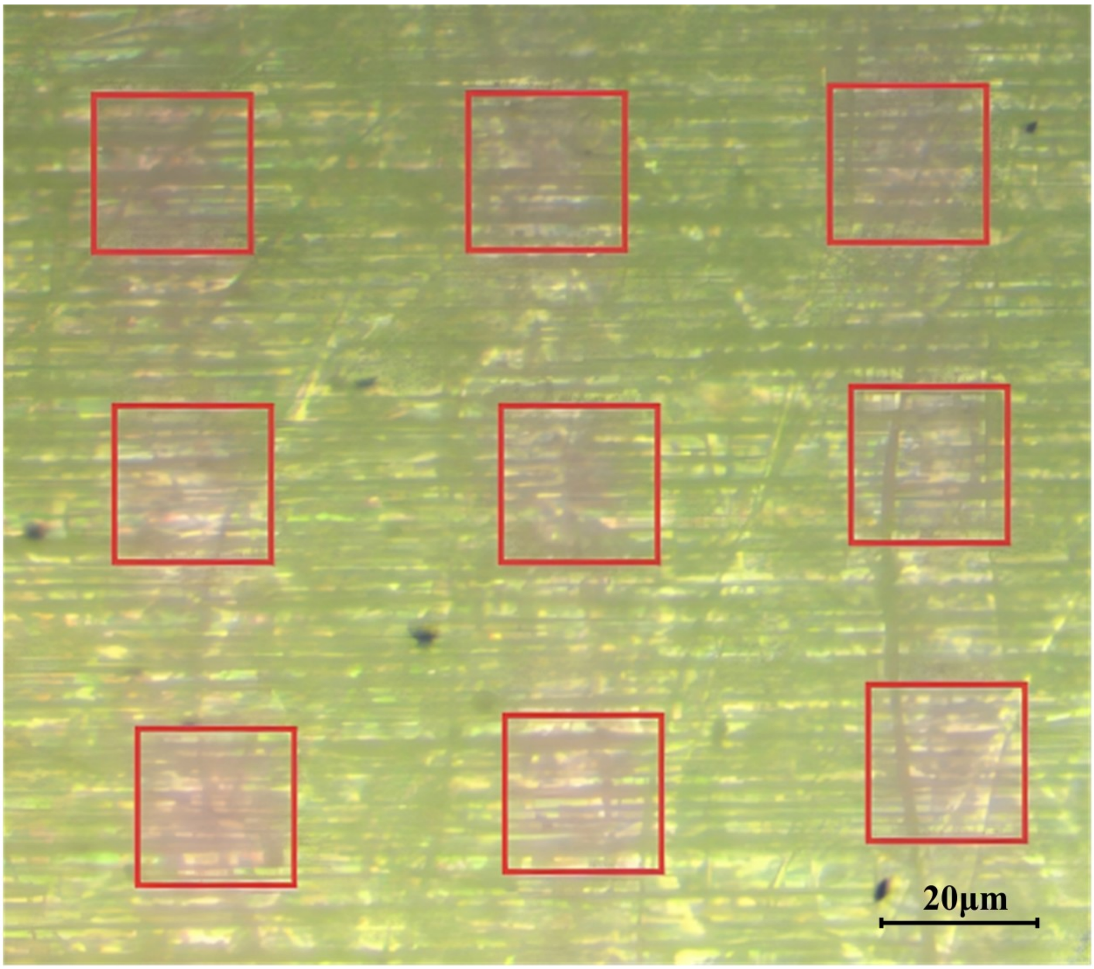

Fig.S3 Optical micrograph of a 3×3 OESD device array fabricated by magnetron sputtering. The red box indicates the device unit area. Scale bar: 20 μm.

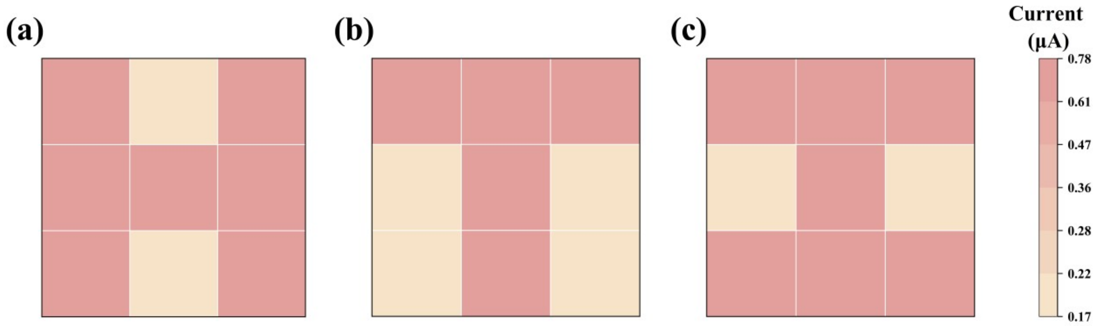

Fig.S4 Image learning capability of the 3×3 OESD array. (a) Image mapping diagrams for the letters H, T, and I at a voltage of 0.1 V.

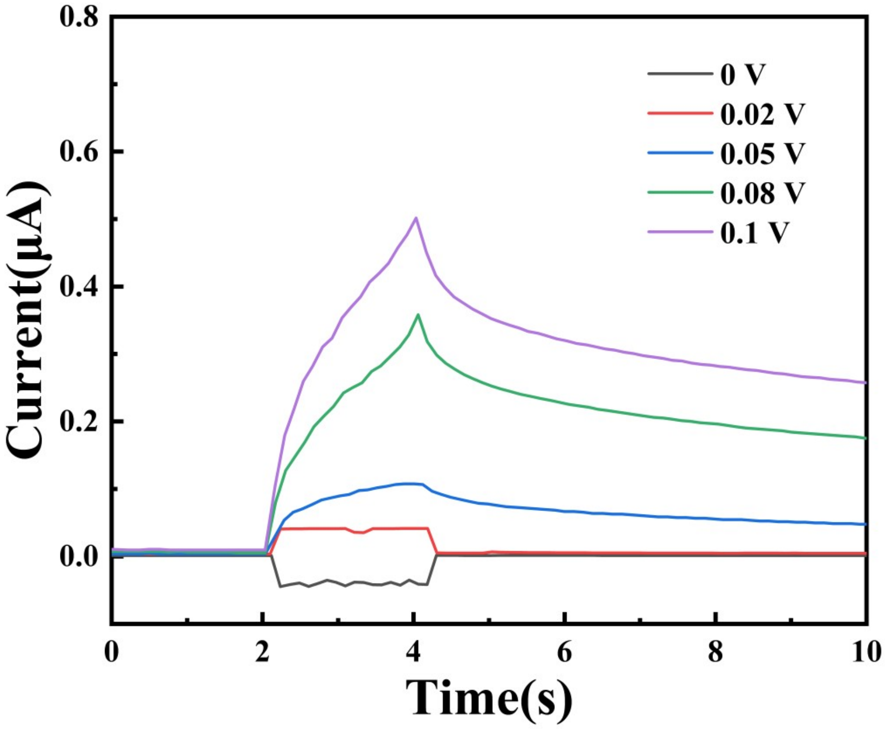

Fig.S5 I-t Curves at Different Bias Voltages

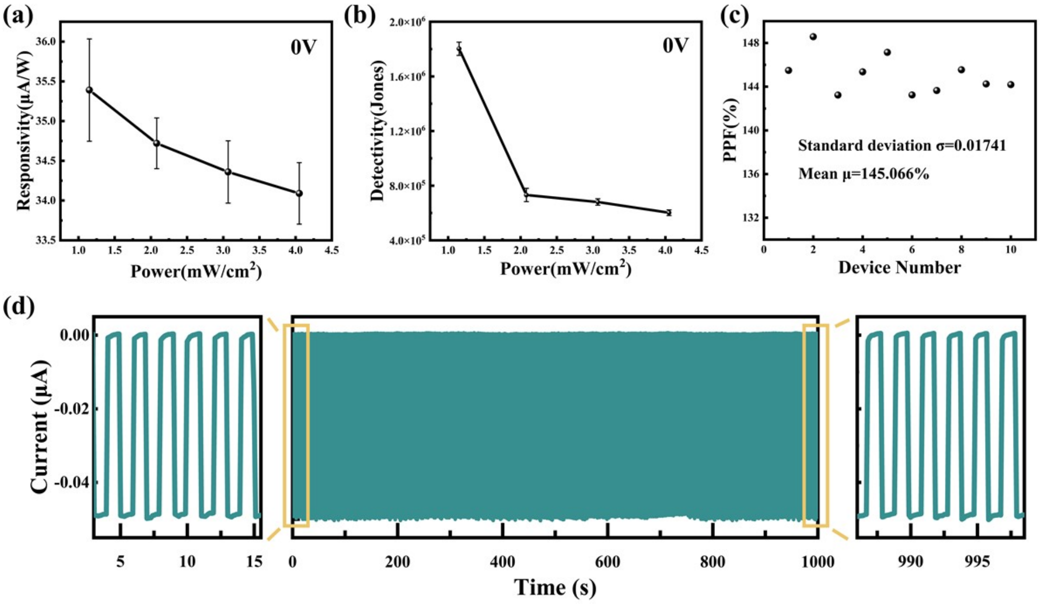

Fig.S6 Stability Analysis of ITO/PZT/ITO Devices (a) Responsivity at different input powers. (b) Detectivity at different input powers. (c) PPF Distribution for 10 Devices (d) more than 1,000 light pulses

Table S2. Comparison of Performance Parameters Between PZT-Based Artificial Photonic Synapses and Previously Reported Ferroelectric Synapses

Ferroelectric synaptic devices	PPF (%)	energy consumption	Pulse interval (s)	Retention time	Ref.
Cu/Ti_3C_2/PZT/Pt	80.9	$\approx 5.6\times10^{-8}$J	0.02	3000	43
Cu/PZT/Pt	73.6	$\approx 4.8\times10^{-8}$J	0.02	4000	44
Au/Cr/BF-BT/SRO	181	2.0×10^{-11}J	0.4	—	45
Au/10% La:HfO_2/LNO/Si	123	$\approx 1.3\times10^{-8}$J	0.3	1500	46
Al:HfO_2 MFMIS-FET	147	$\approx 2.8\times10^{-12}$J	2.5×10^{-7}	—	47
Pd/HfO_2:Gd/LSMO/STO/Si	98	$\approx 4.0\times10^{-11}$J	2.5×10^{-6}	1.8×10^{4}	48
Au/MXene/Y:HfO_2/FTO	122	$\approx 3.0\times10^{-2}$J	0.2	—	49
ITO/PZT/ITO	148.2	$\approx 4\times10^{-8}$J	1	60	Our work