

## Supplementary Information for

# Synaptic plasticity and handwritten digits recognition of memristor based on high-stability lead-free Cs<sub>3</sub>Bi<sub>2</sub>Br<sub>9</sub> perovskite thin film

Jian Liu,<sup>\*a</sup> Ying Nie,<sup>a</sup> Xiaolong Zhou,<sup>a</sup> Juanjuan Qi,<sup>a</sup> Dongke Li,<sup>b</sup> Jianqiang Luo<sup>c</sup> and Ke Wang<sup>\*ad</sup>

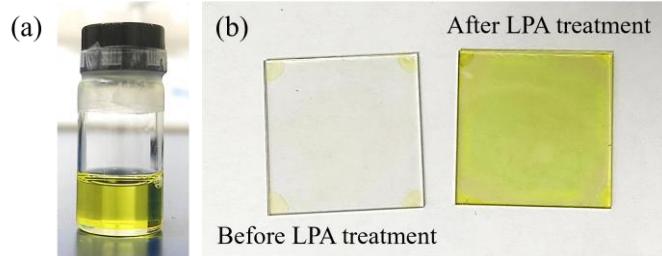
<sup>a</sup> School of Mechanical and Electronic Engineering, East China University of Technology, Nanchang, 330013, China

<sup>b</sup> Hangzhou Global Scientific and Technological Innovation Center, School of Materials Science and Engineering, Zhejiang University, Hangzhou, 311200, China

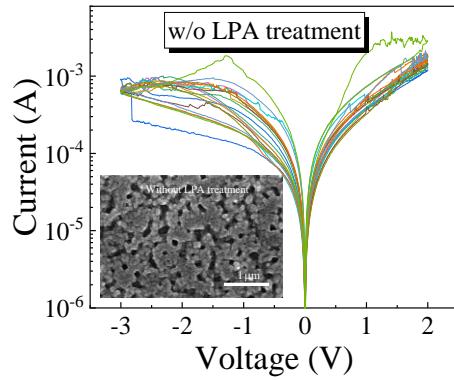
<sup>c</sup> School of Chemistry and Materials Science, East China University of Technology, Nanchang, 330013, China

<sup>d</sup> Jiangxi Province Key Laboratory of Nuclear Physics and Technology, East China University of Technology, Nanchang, 330013, China

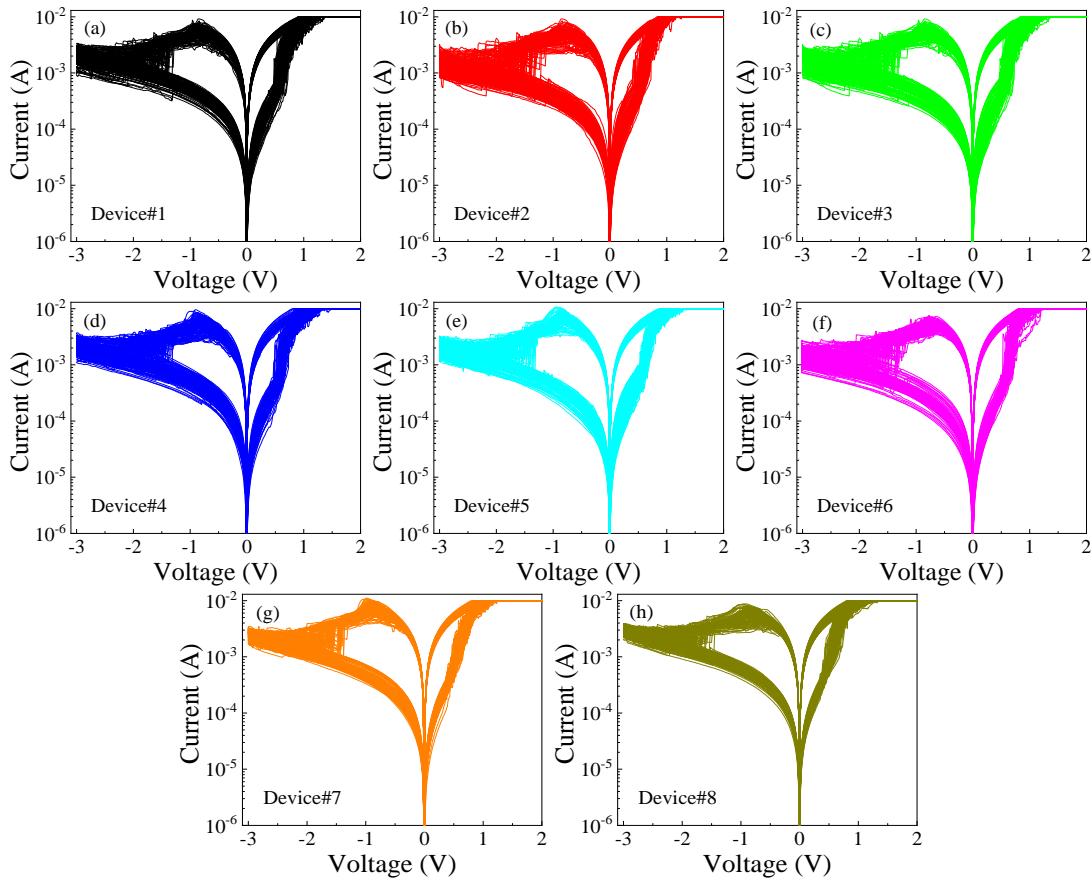
\*Author to whom correspondence should be addressed: [liuj@ecut.edu.cn](mailto:liuj@ecut.edu.cn), [wang@ecut.edu.cn](mailto:wang@ecut.edu.cn)



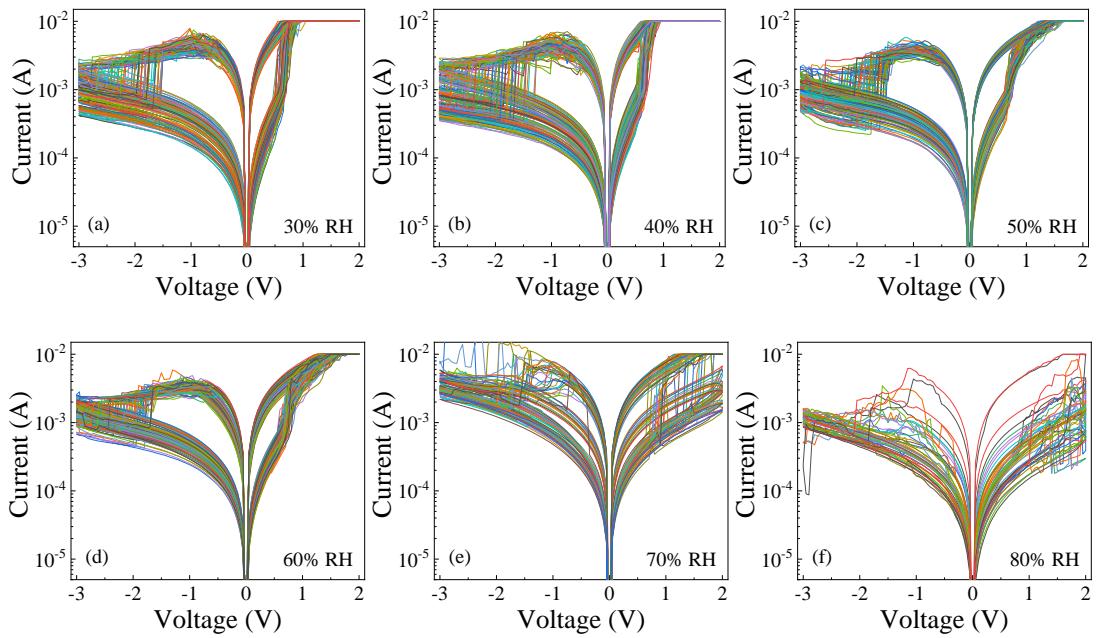
**Fig. S1** Optical micrographs of (a) Cs<sub>3</sub>Bi<sub>2</sub>Br<sub>9</sub> precursor solution and (b) Cs<sub>3</sub>Bi<sub>2</sub>Br<sub>9</sub> film before and after LPA treatment.



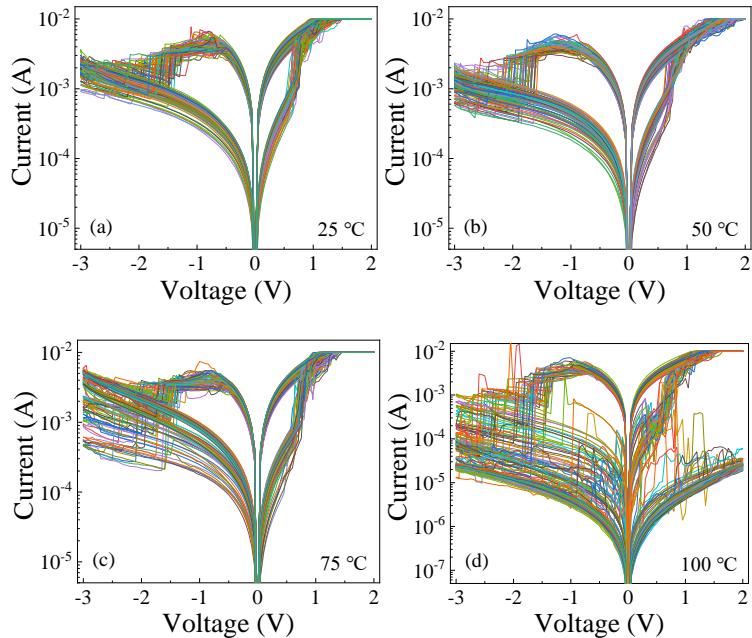
**FIG. S2**  $I$ - $V$  characteristics of the Cs<sub>3</sub>Bi<sub>2</sub>Br<sub>9</sub> thin film memristor without LPA treatment.



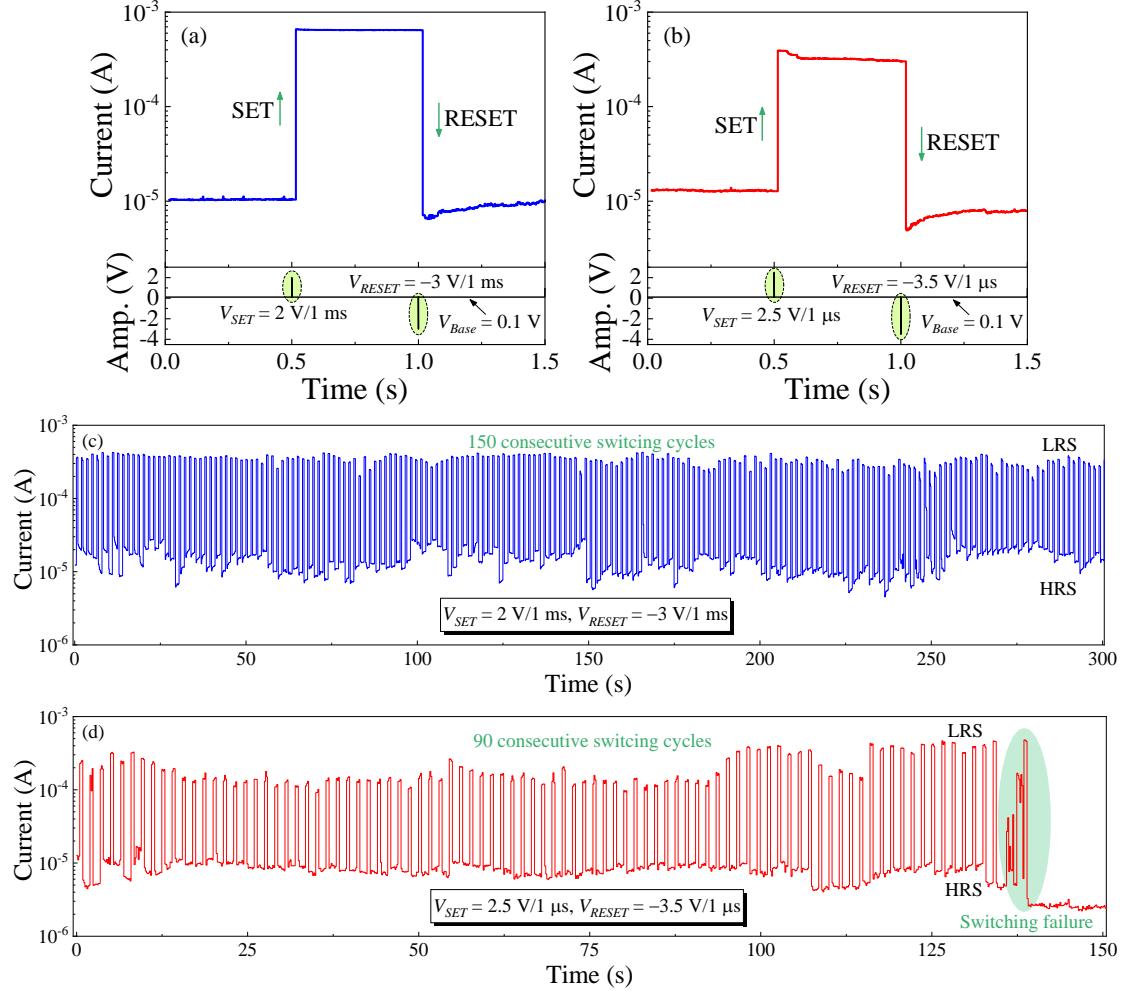
**FIG. S3** Resistive switching performance of 8 devices in different regions of the same sample.



**Fig. S4** Environmental robustness testing of the W/Cs<sub>3</sub>Bi<sub>2</sub>Br<sub>9</sub>/ITO memristor under a relative humidity range of 30% to 80%.



**Fig. S5** Environmental robustness testing of the W/Cs<sub>3</sub>Bi<sub>2</sub>Br<sub>9</sub>/ITO memristor under a working temperature range of 25 to 100 °C.



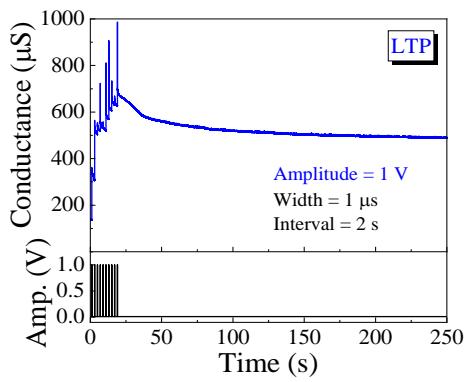
**Fig. S6** Real-time monitoring of SET and RESET switching characteristics: (a) and (b) single pulse switching cycle test with pulse width of ms and  $\mu\text{s}$ , respectively; (c) and (d) consecutive pulse switching cycles test with pulse width of ms and  $\mu\text{s}$ , respectively.

Table S1. Summary of the performance of perovskite-based memristors.

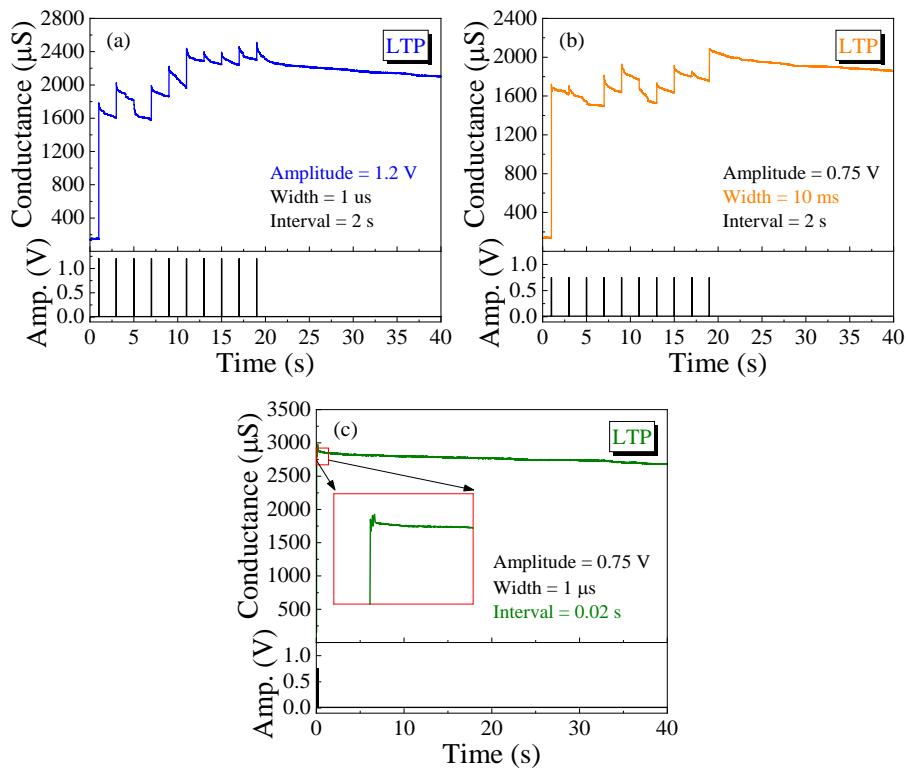
Structure	$R_{HRS}/R_{LRS}$	$V_{SET}$ (V)	$V_{RESET}$ (V)	Endurance	Stability	Reference
Ag/PMMA/CsSnI <sub>3</sub> /Pt	1000	0.13	-0.08	650	/	[1]
Al/Cs <sub>3</sub> Bi <sub>2</sub> I <sub>9</sub> /ITO	10000	0.22	-0.42	410	/	
Al/Cs <sub>3</sub> Bi <sub>2</sub> Br <sub>9</sub> /ITO	10	0.67	-1.21	600	/	[2]
Al/Cs <sub>3</sub> Bi <sub>2</sub> Cl <sub>9</sub> /ITO	100	0.44	-0.97	410	/	
Al/CsBi <sub>3</sub> I <sub>10</sub> /ITO	100	-1.7	0.9	150	2 months	[3]
Au/MAPbI <sub>3-x</sub> Cl <sub>x</sub> /FTO	3	0.8	-0.6	100	/	[4]
Au/Cs <sub>2</sub> AgBiBr <sub>6</sub> /ITO	10	1.53	-3.4	1000	100 days	[5]
Au/(MA) <sub>3</sub> Bi <sub>2</sub> I <sub>9</sub> /ITO	100	1.6	-0.6	300	1 month	[6]
Ag/Cs <sub>3</sub> Cu <sub>2</sub> I <sub>5</sub> /ITO	10	0.6	-0.44	50	/	[7]
Ag/PMMA/Cs <sub>3</sub> Cu <sub>2</sub> I <sub>5</sub> /ITO	100	0.2	-0.45	100	/	
Au/CsPbBr <sub>3</sub> /ITO	10	0.29	-0.22	400	/	[8]
Ag/BA <sub>0.15</sub> MA <sub>0.85</sub> PbI <sub>3</sub> /FTO	1000	-1.1	1.5	1600	/	[9]

Ag/BA <sub>0.15</sub> FA <sub>0.85</sub> PbI <sub>3</sub> /FTO	1000	-0.3	1.2	1000	/	
Au/CsPbBr <sub>3</sub> /Au	10	0.65	-0.98	200	/	[10]
Ag/CsPb <sub>1-x</sub> Bi <sub>x</sub> I <sub>3</sub> /ITO	10	-0.5	3.5	500	5 days	[11]
Ag/Cs <sub>3</sub> Bi <sub>2</sub> I <sub>9</sub> /FTO	1000	0.3	-0.5	1000	1 month	[12]
Ag/Cs <sub>3</sub> Bi <sub>2</sub> Br <sub>9</sub> /ITO	10	-0.5	0.75	3200	7 days	[13]
Al/CsPbBr <sub>3</sub> QD/ITO	100000	-0.45	2.2	1000	200 days	[14]
Al/Cs <sub>2</sub> AgBiBr <sub>5</sub> Cl/ITO	10000	-0.21	1.34	100	100 days	[15]
Ag/(BA) <sub>2</sub> CsAgBi <sub>7</sub> /Pt	10000000	0.13	-0.20	1000	22 days	[16]
W/Cs <sub>3</sub> Bi <sub>2</sub> Br <sub>9</sub> /ITO	10	0.53	-0.83	1100	> 11 months	This work

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**FIG. S7** Long-term plasticity (LTP) up to 250 s after pulse-train stimulation is withdrawn.



**FIG. S8** Greater amplitude (a) and width (b) of pulse-train or shorter intervals between adjacent pulses (c) result in higher values of the final conductance state when transitioning to LTP.