Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

Pen-writing high-quality perovskite films and degradable optoelectronic devices

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Supplementary Materials:

Supplementary Figure 1-7

Supplementary Table 1-2

Supplementary Movie 1

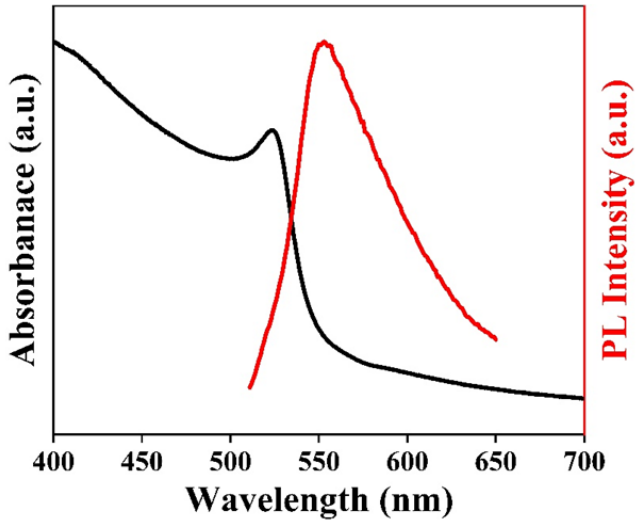

Fig. S1 Visible absorption and photoluminescence (PL) spectra of the prepared $CH_3NH_3PbBr_3$ films by spin-coating.

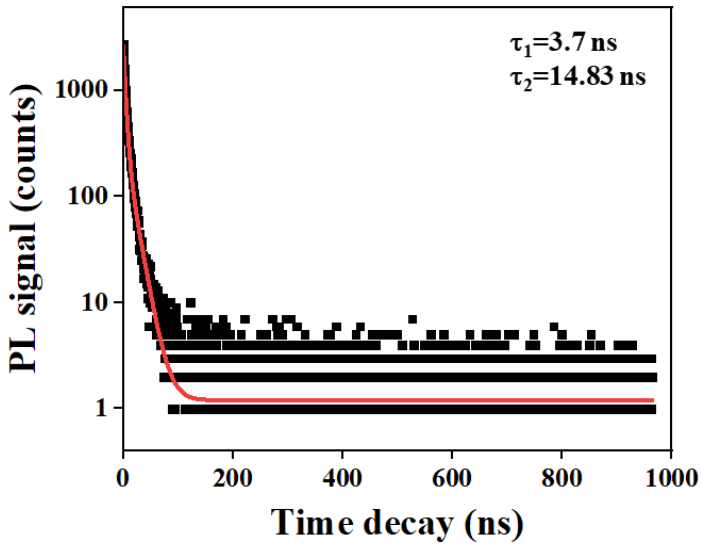

Fig. S2 PL time decay trace of the $CH_3NH_3PbBr_3$ films by spin-coating at 405 nm showing a fast component (τ'_1 = 3.7 ns) and a slow component (τ'_2 = 14.83 ns).

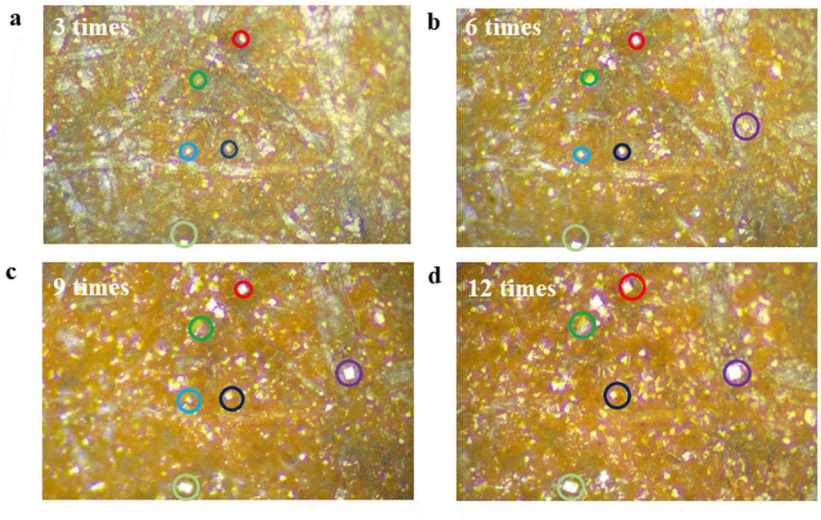

Fig. S3 In-situ growth process of the pen-written $CH_3NH_3PbBr_3$ films at different writing cycles. a) 3 times. b) 6 times. c) 9 times. d) 12 times. Circles of the same color represent the crystal of different times. The film coverage and crystal size are positively related with writing times. As the writing times increase, the coverage and crystal size increase.

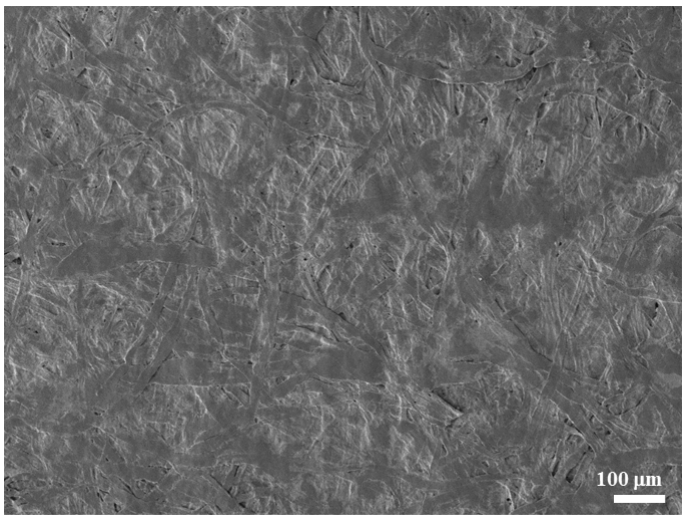

Fig. S4 SEM image of the $CH_3NH_3PbBr_3$ perovskite films by spin-coating.

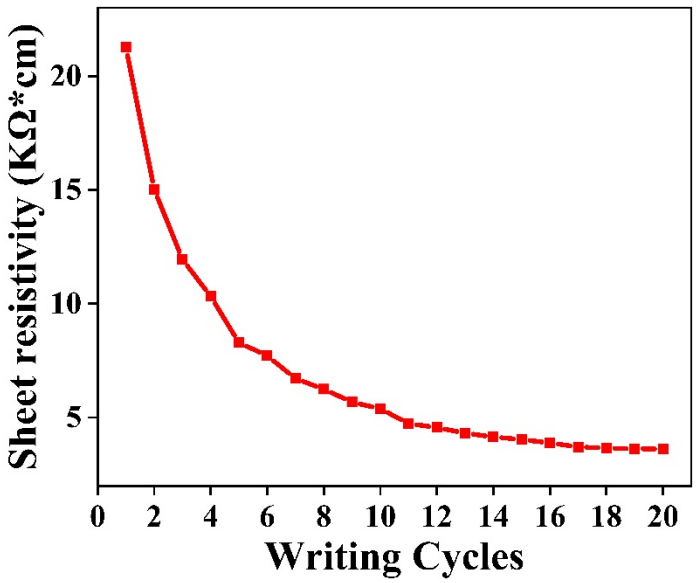

Fig. S5 The resistivity of pencil-drawn graphite electrodes on papers as a function of writing cycles.

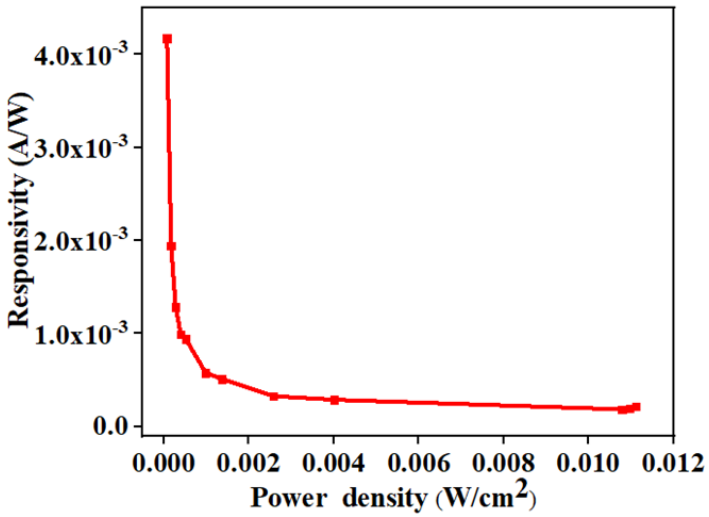

Fig. S6 Responsivity of the pen-written photodetectors (bias, 4 V; λ = 405 nm).

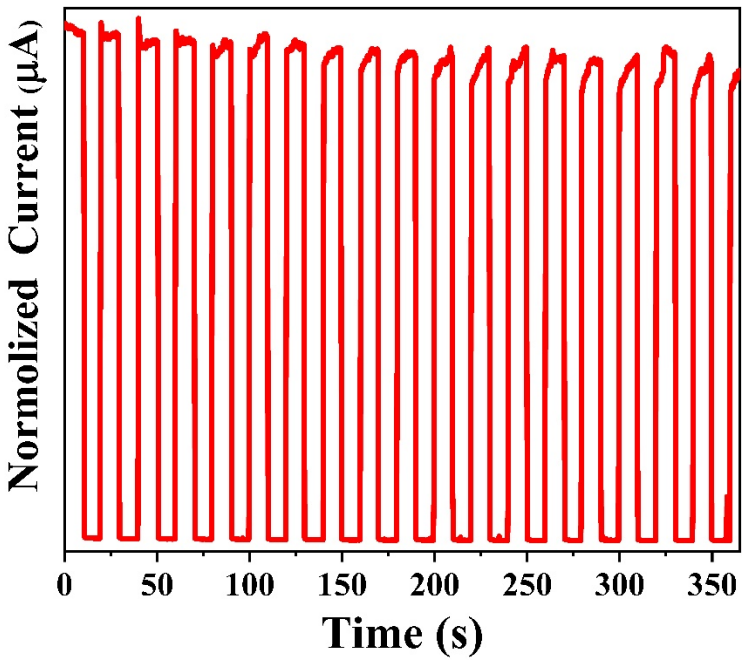

Fig. S7 Photoswitching behavior of the photodetector.

Device type	Wavelength (nm)	On/off current ration	Responsivity [mA/W]	References
$Cs_2NaBiCl_6$/ITO	365	25	67.98@1.5V	J. Phys. Chem. Lett. 2021, 12, 5682−5688.
Au/$Cs_3Cu_2I_5$/SiO_2	265	22	22.1@3V	J. Phys. Chem. Lett. 2020, 11, 16, 6880–6886.
$MAPbBr_3$/InGa/SiO_2	532	100	0.45×10^3@2V	ACS Appl. Mater. Interfaces 2018, 10, 25763-25769.
$MAPbI_3$/graphite/paper	633	32	4.4@5V	ACS Appl. Mater. Interfaces, 2017, 9, 10921−10928.
Au/$CH_3NH_3PbI_xCl_{3-x}$:PCBM/Au		100	23@5V	ACS Appl. Mater. Interfaces, 2017, 9, 15638–15643.
$MAPbBr_3$/ graphite /paper	405	10^2	4.2@3 V	This work

Table S1 Device performance of perovskite-based photodetectors.

Perovskite films	τ_1(ns)	τ_2(ns)	A_1	A_2	A_0	χ^2
$CH_3NH_3PbBr_3$ films by pen-writing	29.02 (65.00%)	186.65 (35.00%)	3580.94	299.77	0.75	1.094
$CH_3NH_3PbBr_3$ films by spin-coating	3.7 (66.22%)	14.83 (33.78%)	2617.4	333.04	1.201	0.864

Table S2 The parameters for fluorescence lifetime of $CH_3NH_3PbBr_3$ films. The photoluminescence decay graph is fitted by a bi-exponential function "$F(t)= A_0+ A_1 e^{(-t/\tau 1)}+A_2e^{(-t/\tau 1)}$", where F(t) is the decay model; A_0, A_1, and A_2 are constants; τ_1 and τ_2 are the lifetime components.