Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Bifunctional Resistive Switching Behaviors in Organolead Halide Perovskite Based Ag/$CH_3NH_3PbI_{3-x}Cl_x$/FTO Structure

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Table of the contents:

In a typical process, $CH_3NH_3PbI_{3-x}Cl_x$ solution was prepared as follows. Methylammonium iodide (MAI) was prepared according to a previous report.[1] The as-synthesized MAI was re-crystallized in the ethanol and diethyl ether to produce white-colored powder. All the other chemicals mentioned in this work were used as received. Chlorine-doped perovskite solution ($CH_3NH_3PbI_{3-x}Cl_x$) was prepared as follows: MAI and lead (II) chloride (Sigma-Aldrich) at a 3:1 molar ratio with a concentration of 50 wt% in anhydrous N, N-Dimethylformamide (DMF) solution. The solution was filtered by 0.45 μm syringe filter before use. [1]

2. Figures

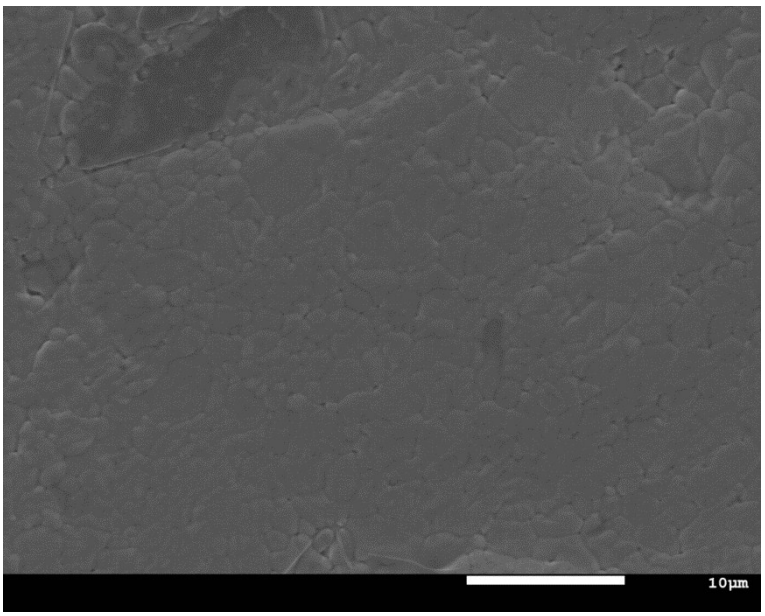

Figure S1. SEM image of the surface morphology of the spin coated $CH_3NH_3PbI_{3-x}Cl_x$ film on the FTO substrate.

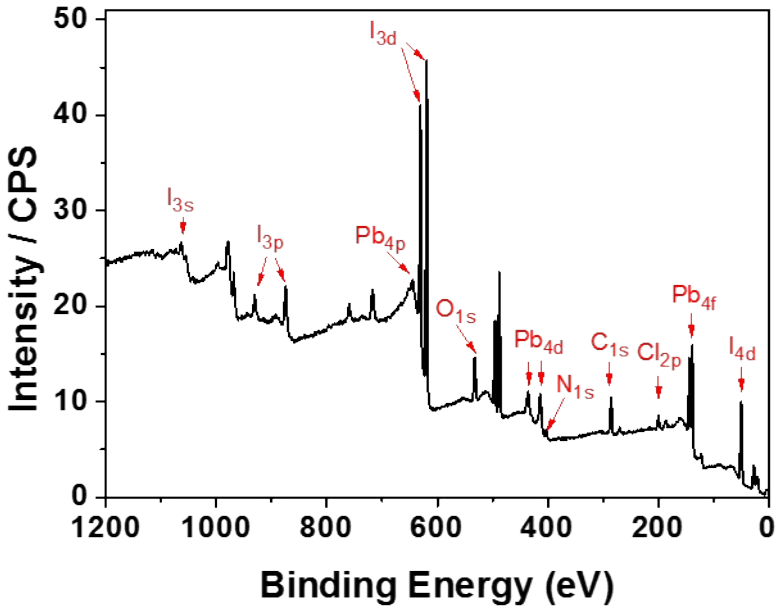

Figure S2 XPS survey spectra of $CH_3NH_3PbI_{3-x}Cl_x$ film including the N, C, I, Pb, and Cl elements.

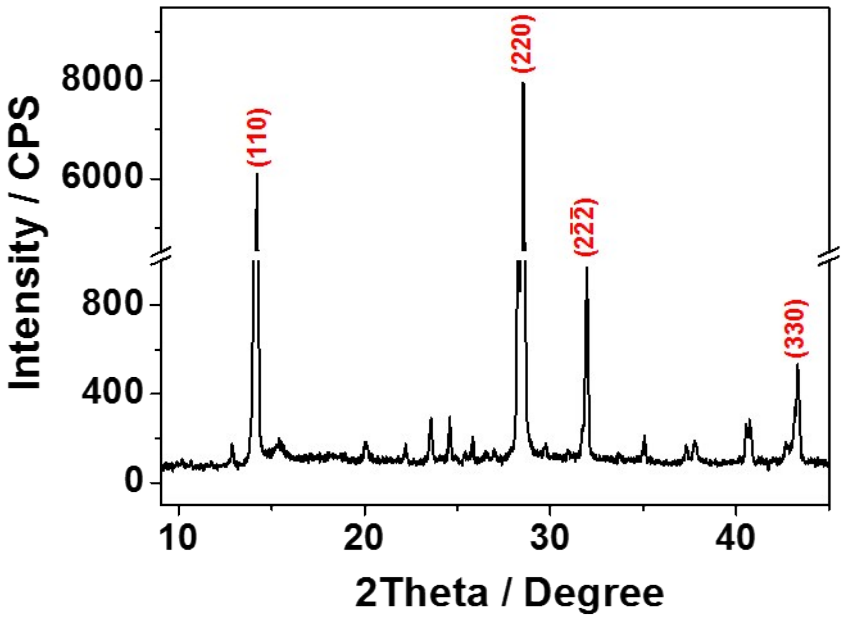

Figure S3 XRD pattern of well-crystallized $CH_3NH_3PbI_{3-x}Cl_x$ film.

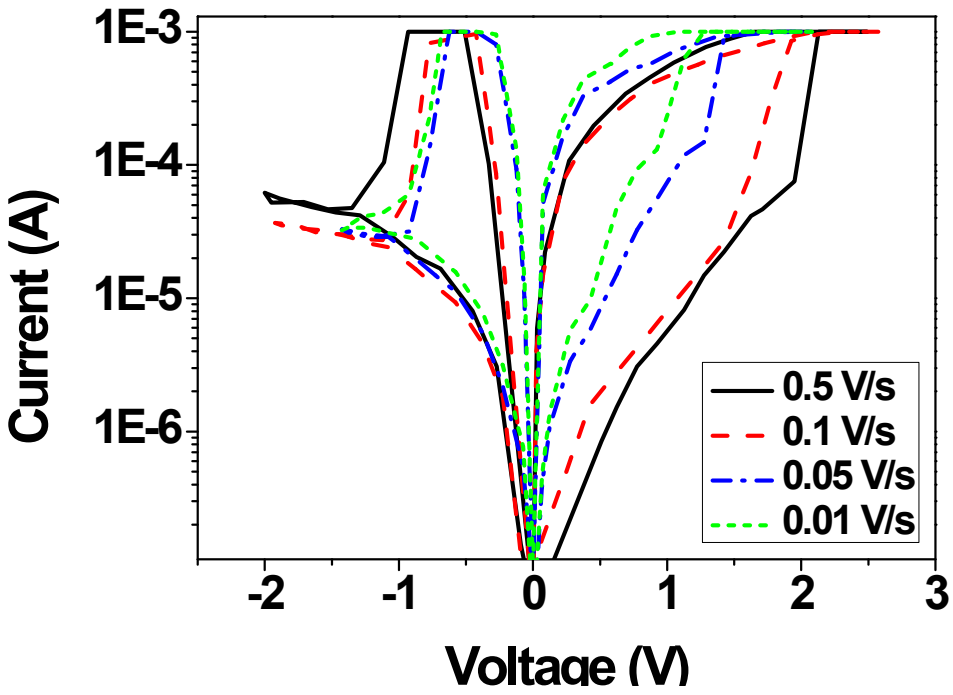

Figure S4 I – V characteristics under 4 different bias sweeping rates of 0.5 V/s, 0.1 V/s, 0.05 V/S, and 0.01 V/s.

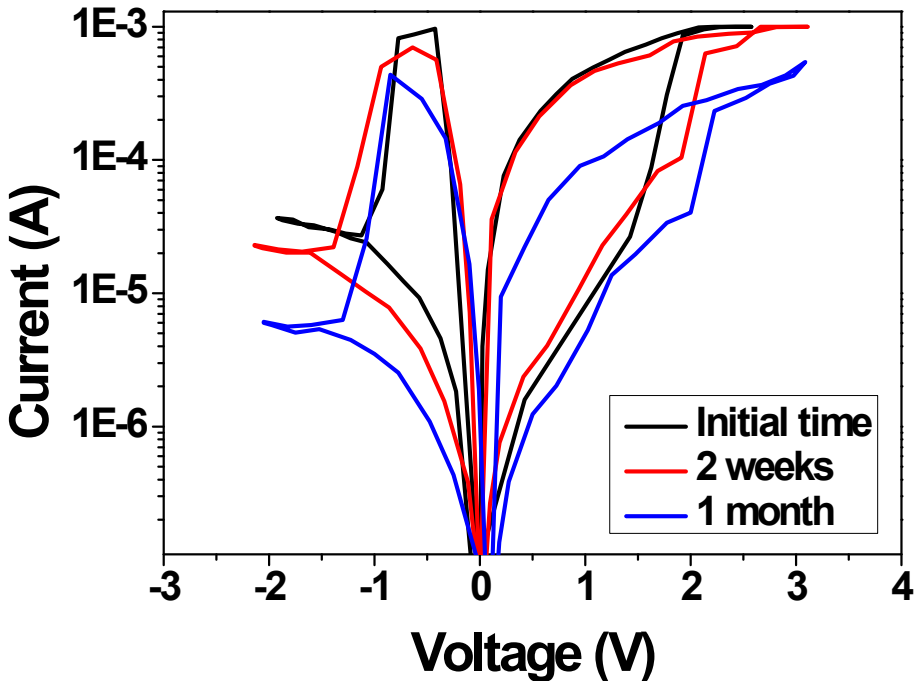

Figure S5. Stability of Ag/$CH_3NH_3PbI_{3-x}Cl_x$/FTO with long interval of 2 weeks and 1 month.

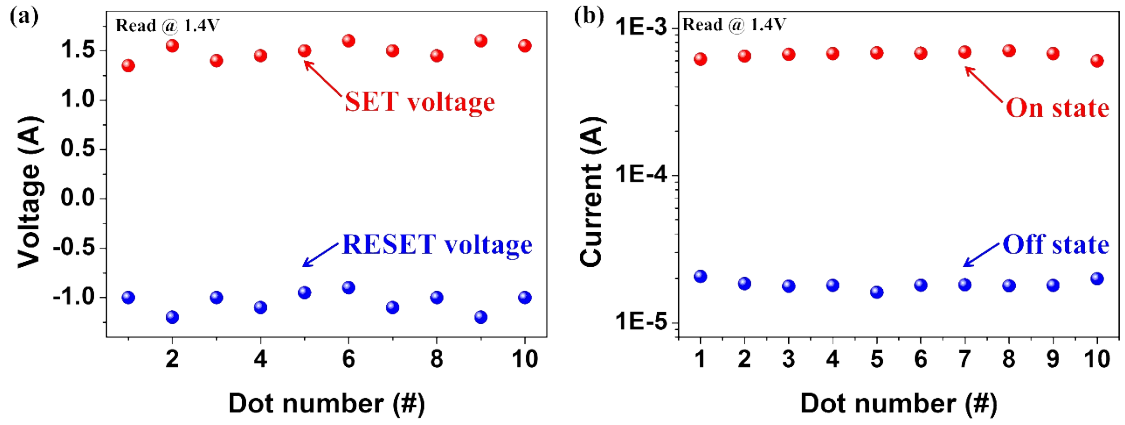

Figure S6 Distribution of SET/RESET voltage (a) and current values (b) at 10 points in the same sample.

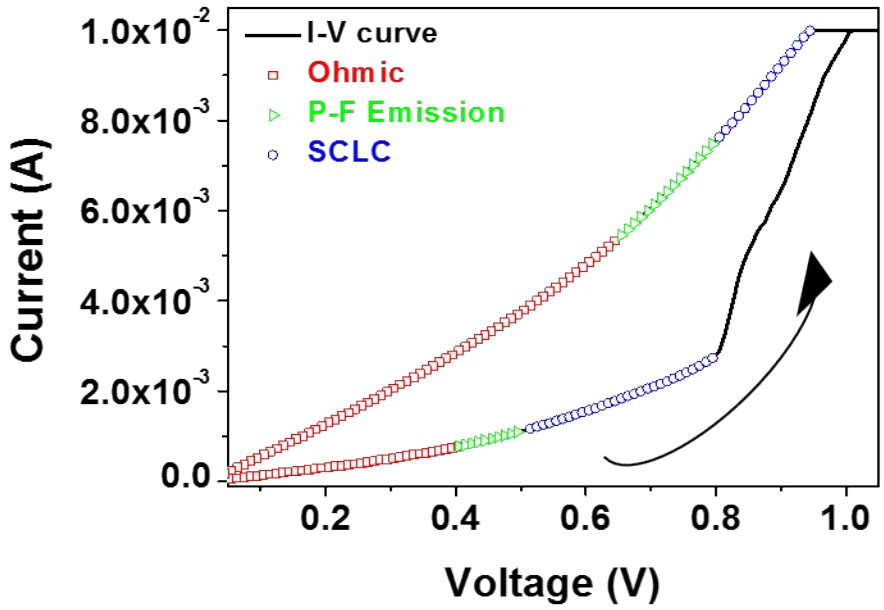

Figure S7 Analysis of conduction mechanism in the Au/$CH_3NH_3PbI_{3-x}Cl_x$/FTO structured device under the SET process.

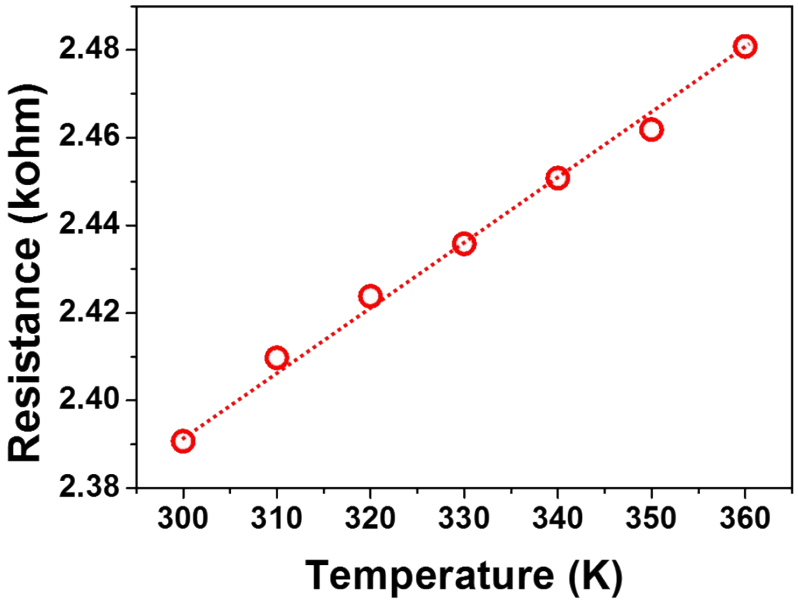

Figure S8. Temperature dependence of the resistance at LRS.

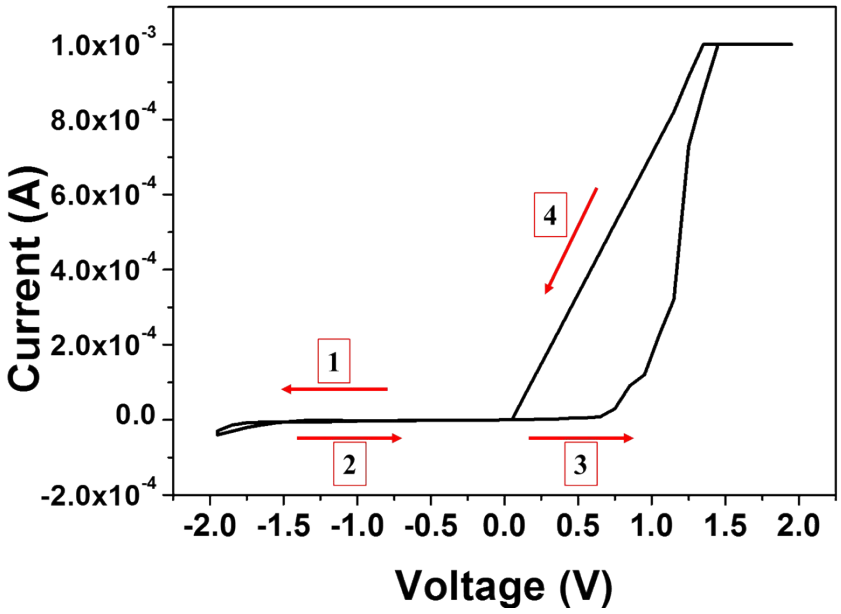

Figure S9 I – V characteristics when the negative voltage bias is applied to Ag electrode first.

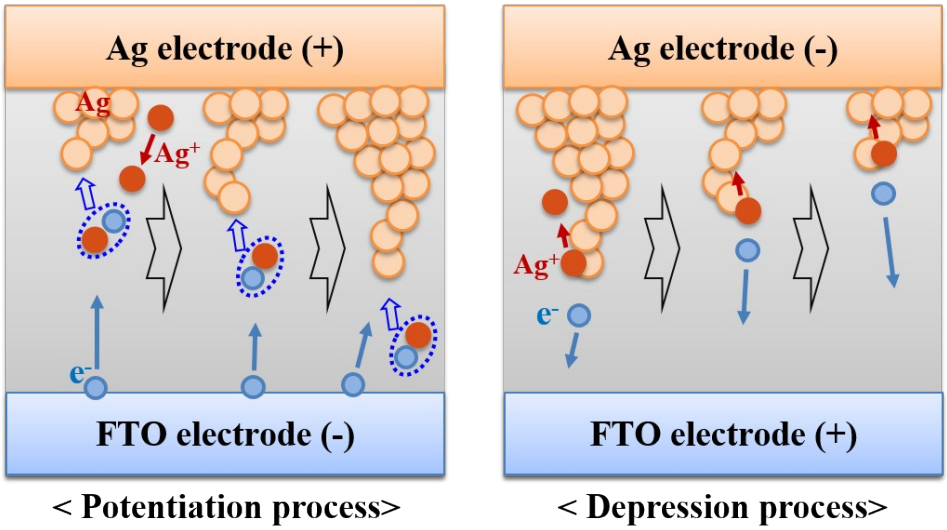

Figure S10 Illustration of potentiation (left) and depression (right) process by repeating the voltage sweeps.

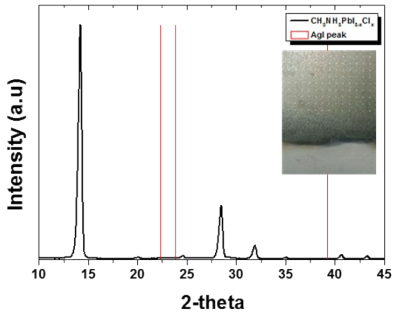

Figure S11. XRD pattern and image of full device after stored in a desiccator with humidity of ~ 30% for 2 months.

REFERENCE

1. M. M. Lee, J. Teuscher, T. Miyasaka, T. N. Murakami and H. J. Snaith, *Science*, 2012, 338, 643-647.