Supplementary Information

Solution-processed visible-blind UV-A photodetectors based on $CH_3NH_3PbCl_3$ perovskite thin films

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One-step spin coating

Equal mole CH_3NH_3Cl and $PbCl_2$ were dissolved in DMSO-DMF (1:1 by volume) to get a 1 M $CH_3NH_3PbCl_3$ precursor solution. The precursor was stirred for 12 h at 70 °C and filtered by a 0.2 μm PTFE filter. 100 μL of precursor was added onto a 15 mm × 15 mm substrate and spin coated at 4000 rpm for 60 s. For thermal annealing, substrates were heated on a hotplate at 70 °C for 60 min. For DMSO-vapor-assisted thermal annealing, substrates were first heated on a hotplate at 70 °C for 60 min. Then the substrates were covered with a glass petri dish on the hotplate, 10 μL of DMSO was added from the edge of the petri dish and heated at 70 °C for 60 min.

Nano-pinning

Precursor solution was prepared as described above. 100 μL of precursor solution was added onto a 15 mm × 15 mm substrate. Nano-pinning method was performed as reported previously with slight modification.[1] Two spin speeds were applied to perform nano-pinning: 500 rpm for 10 s and then 3000 rpm for 90 s. When 70 s passed, 100 μL of toluene or chloroform was added on the substrate in less than 2 s. For thermal annealing, substrates were heated on a hotplate at 70 °C for 10 min. For DMSO-vapor-assisted thermal annealing, substrates were first heated on a hotplate at 70 °C for 10 min. Then the substrates were covered with a glass petri dish on the hotplate, 10 μL of DMSO was added from the edge of the petri dish and heated at 70 °C for 60 min.

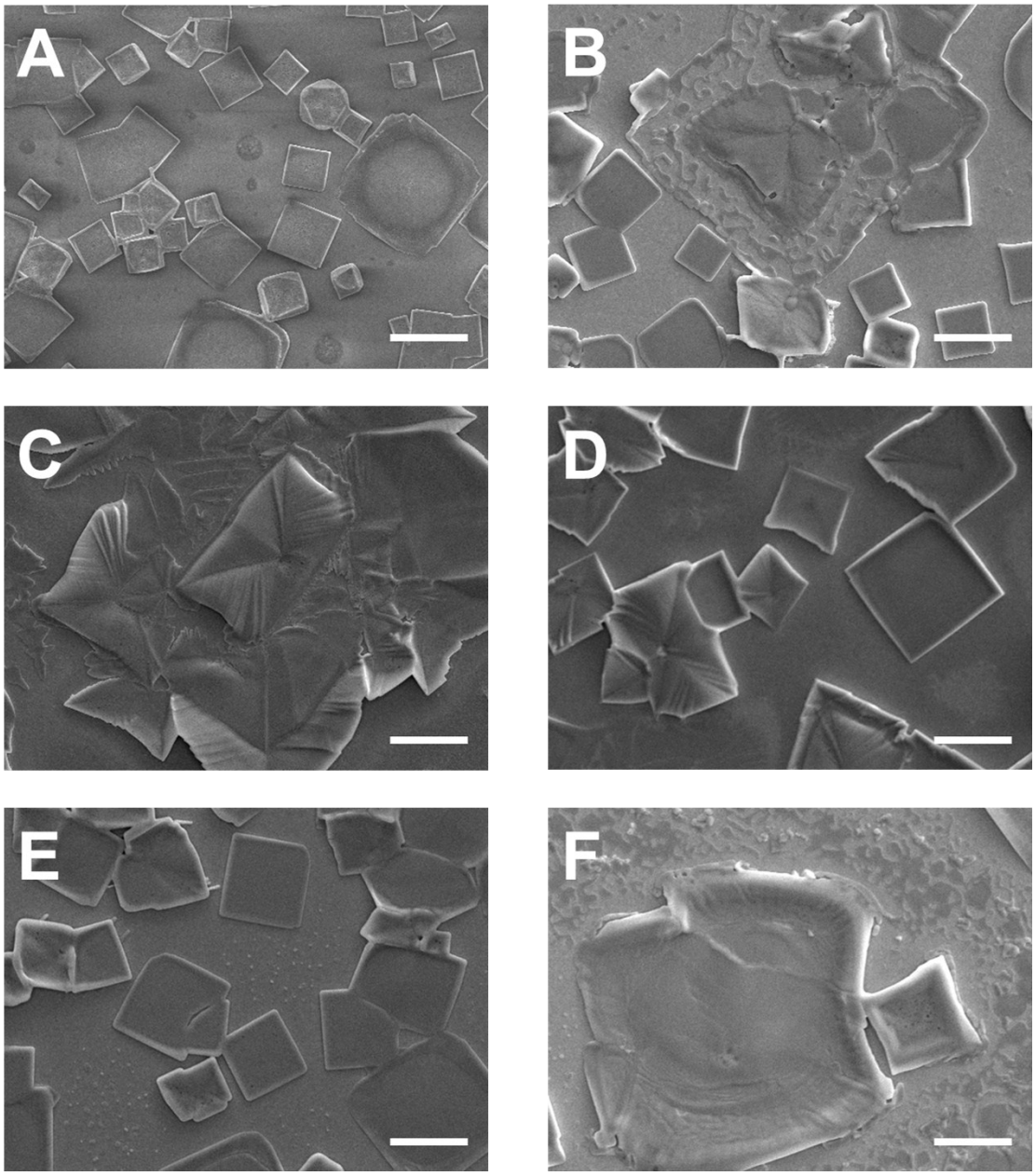

Figure S1. SEM images of $CH_3NH_3PbCl_3$ thin film fabricated via (A) one-step spin coating with thermal annealing, (B) one-step spin coating with DMSO-vapor-assisted thermal annealing, (C) nano-pinning with chloroform followed by thermal annealing, (D) nano-pinning with toluene followed by thermal annealing, (E) nano-pinning with chloroform followed by DMSO-vapor-assisted thermal annealing and (F) nano-pinning with toluene followed by DMSO-vapor-assisted thermal annealing. Scale bar: 10 μm.

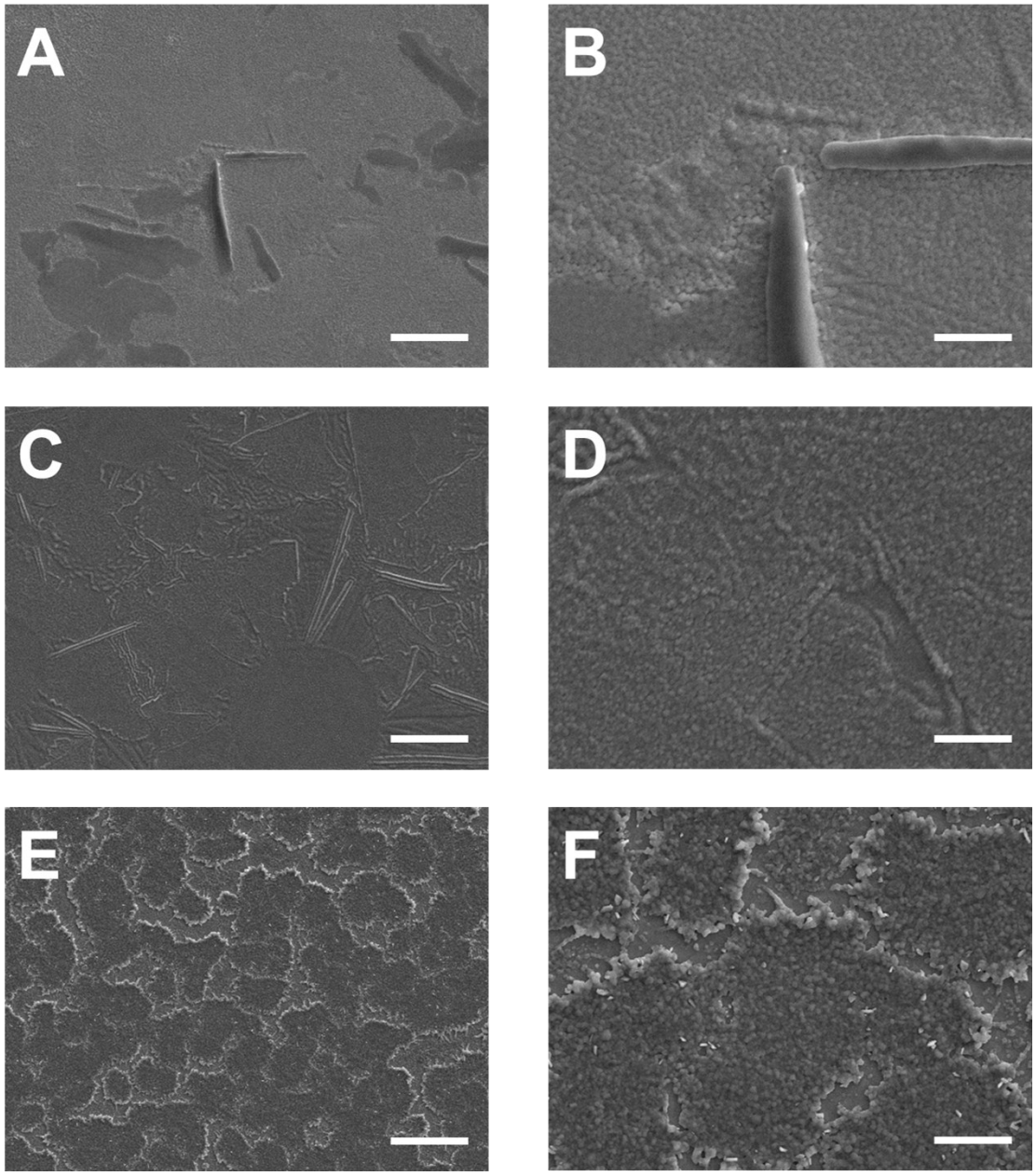

Figure S2. SEM images of $CH_3NH_3PbCl_3$ thin films made by two-step spin coating under different annealing conditions for each layer. $PbCl_2$ layer was annealed at X °C for 10 min. After spin coating CH_3NH_3Cl, the substrates were annealed at Y °C for 30 min. For DMSO-vapor-assisted thermal annealing, the substrates were annealed at Z °C for 1 h. The values of X, Y, and Z were (A, B) 70, 70 and 70; (C, D) 70, 100 and 100; and (E, F) 100, 100 and 100. Scale bars are 20 μm for A, C, E, and 5 μm for B, D, F.

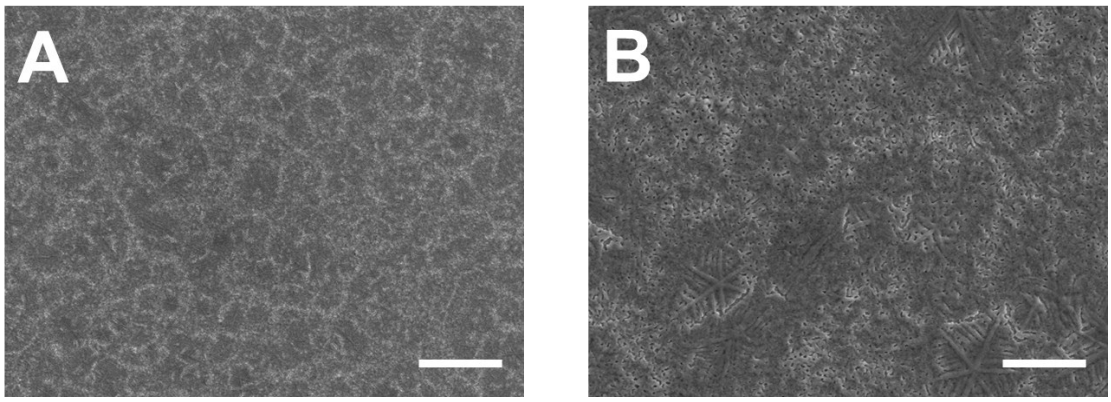

Figure S3. SEM images of $PbCl_2$ thin film annealed at 100 °C for 10 min. Scale bars are 20 µm and 5 µm for A and B, respectively.

Bulk crystal growth

Bulk crystal was grown by inverse temperature crystallization method as reported previously with slight modification.[2, 3] A 1 M $CH_3NH_3PbCl_3$ precursor solution was prepared by dissolving equal mole CH_3NH_3Cl and $PbCl_2$ in DMSO-DMF (1:1 by volume). The solution was then filtered using a PTFE filter with 0.2 µm pore size. The solution was sealed in a 10 mL vial and kept undisturbed for 1 h under 85 °C. The small crystals were kept as seeds. The same procedure was repeated by adding seeds to grow large crystals.

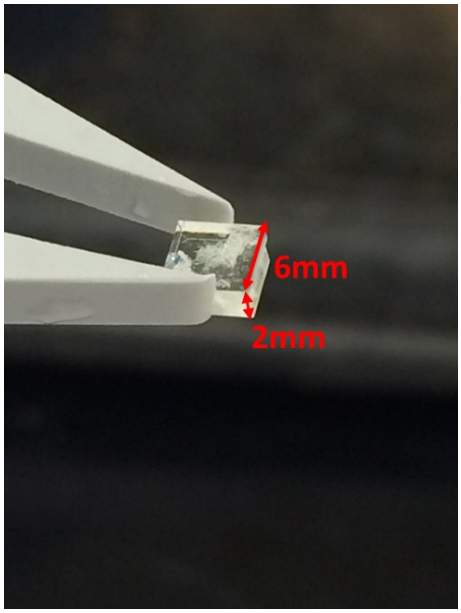

Figure S4. Photograph of $CH_3NH_3PbCl_3$ bulk crystal grown via modified inverse temperature crystallization method.

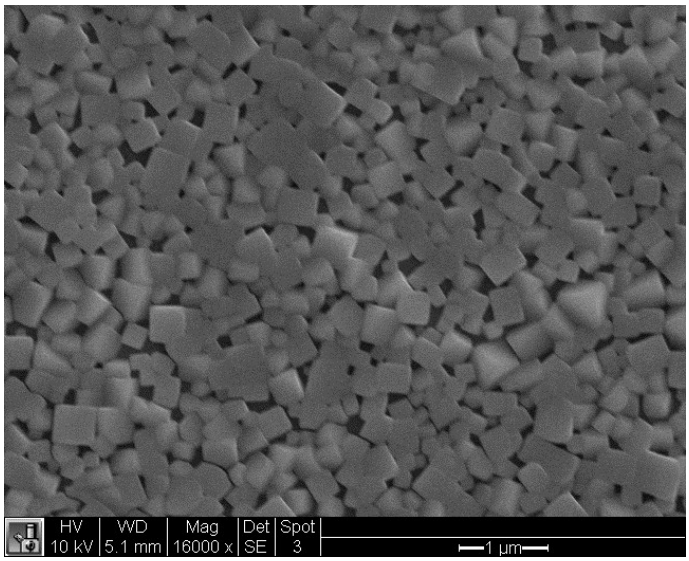

Figure S5. SEM image of the $CH_3NH_3PbCl_3$ thin film fabricated with DMSO-vapor-assisted thermal annealing method when the DMSO droplet was too close to the sample.

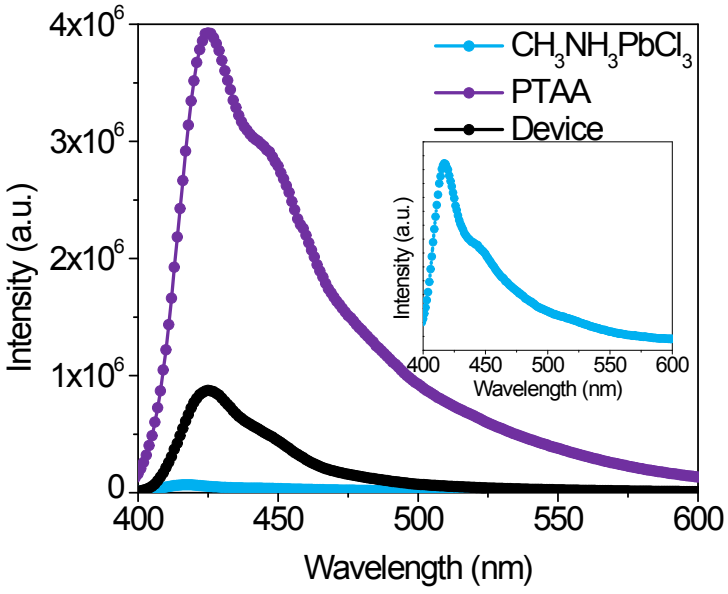

Figure S6. Steady-state photoluminescence spectra of $CH_3NH_3PbCl_3$ thin film, pure PTAA thin film, and the film of PTAA on $CH_3NH_3PbCl_3$ excited from glass side with 360 nm wavelength light.

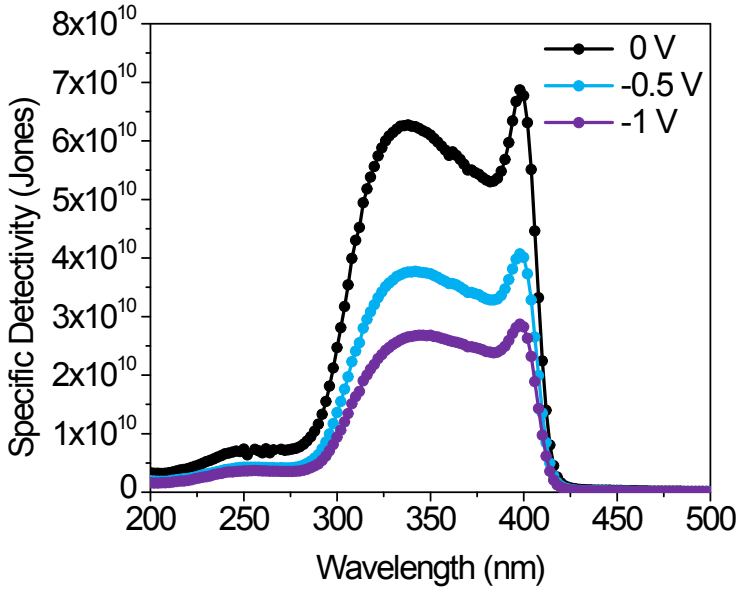

Figure S7. Specific detectivity of the device versus wavelength under different reverse biases.

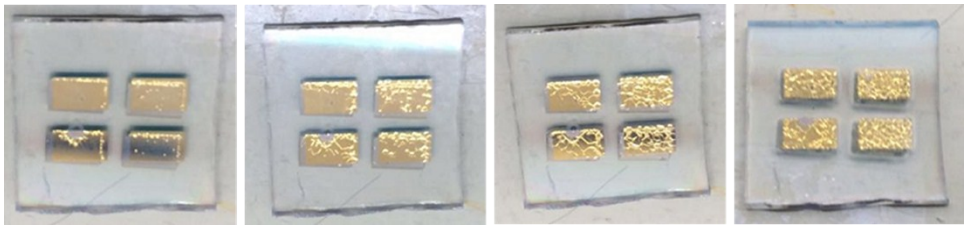

Figure S8. Photograph of devices exposed in ambient air (From left to right: 0 min, 1 min, 2 min, 3min)

References

1. H. C. Cho, S. H. Jeong, M. H. Park, Y. H. Kim, C. Wolf, C. L. Lee, J. H. Heo, A. Sadhanala, N. Myoung, S. Yoo, S. H. Im, R. H. Friend and T. W. Lee, *Science*, 2015, 350, 1222-1225.
2. G. Maculan, A. D. Sheikh, A. L. Abdelhady, M. I. Saidaminov, M. A. Hague, B. Murali, E. Alarousu, O. F. Mohammed, T. Wu and O. M. Bakr, *Journal of Physical Chemistry Letters*, 2015, 6, 3781-3786.
3. M. I. Saidaminov, A. L. Abdelhady, B. Murali, E. Alarousu, V. M. Burlakov, W. Peng, I. Dursun, L. F. Wang, Y. He, G. Maculan, A. Goriely, T. Wu, O. F. Mohammed and O. M. Bakr, *Nature Communications*, 2015, 6, 6.