Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supplementary Information

One-step vapour phase growth of two-dimensional formamidinium-based perovskites and its hot carrier dynamics

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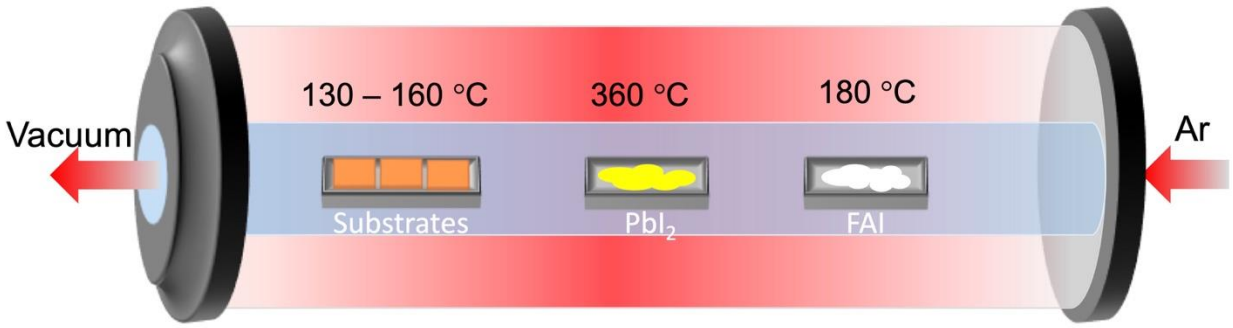

Figure S1. Schematic of CVD setup used for the one-step vapour deposition of FAPI.

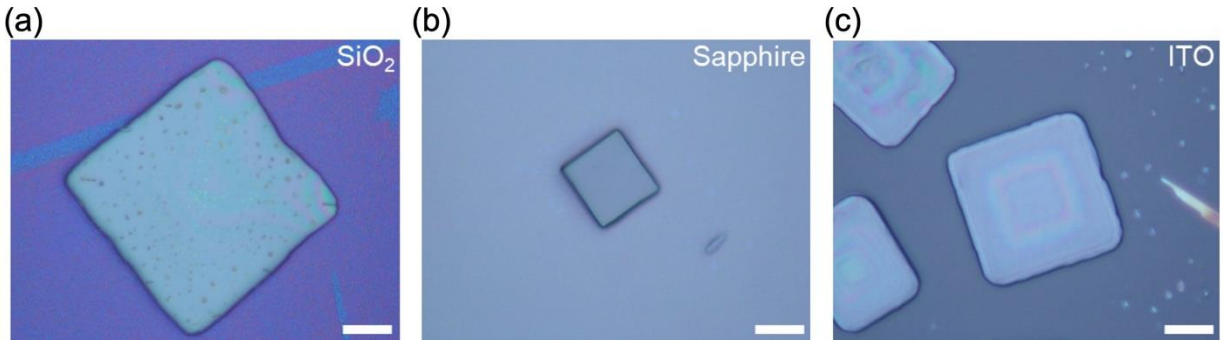

Figure S2. One-step FAPI crystals grown on various substrates. (a) SiO_2, (b) sapphire and (c) ITO. All scale bars are 10 μm.

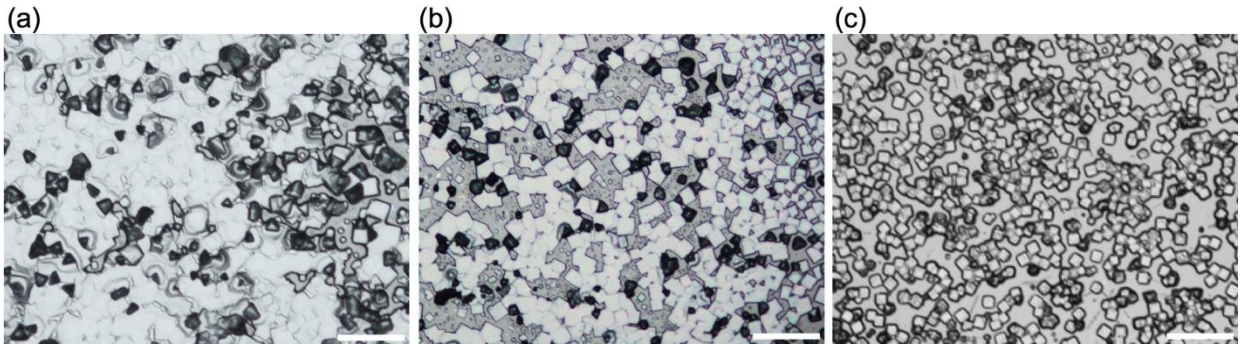

Figure S3. Optical images of one-step cubic FAPI grown on ITO substrates at different substrate temperatures. a) 135 °C, b) 145 °C, c) 155 °C. All scale bars are 100 μm.

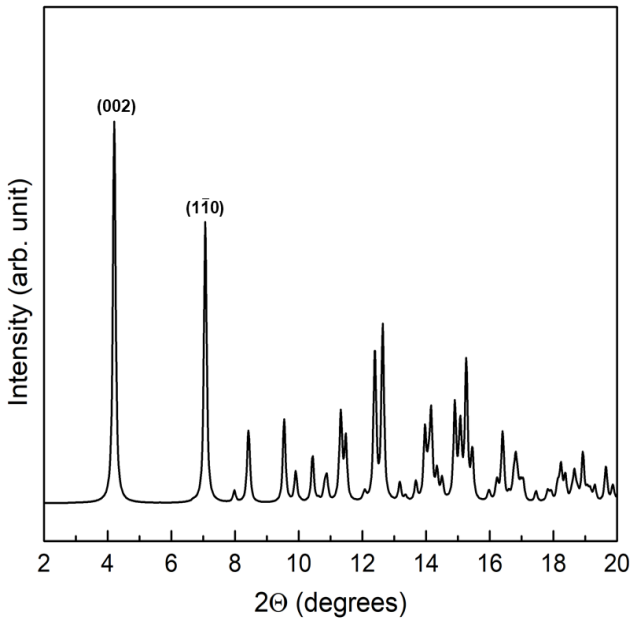

Figure S4. Simulated XRD pattern of FA_2PbI_4 in eclipsed configuration. This XRD pattern is generated using VESTA software[1] from the data reported in ref. 32 in the main text.

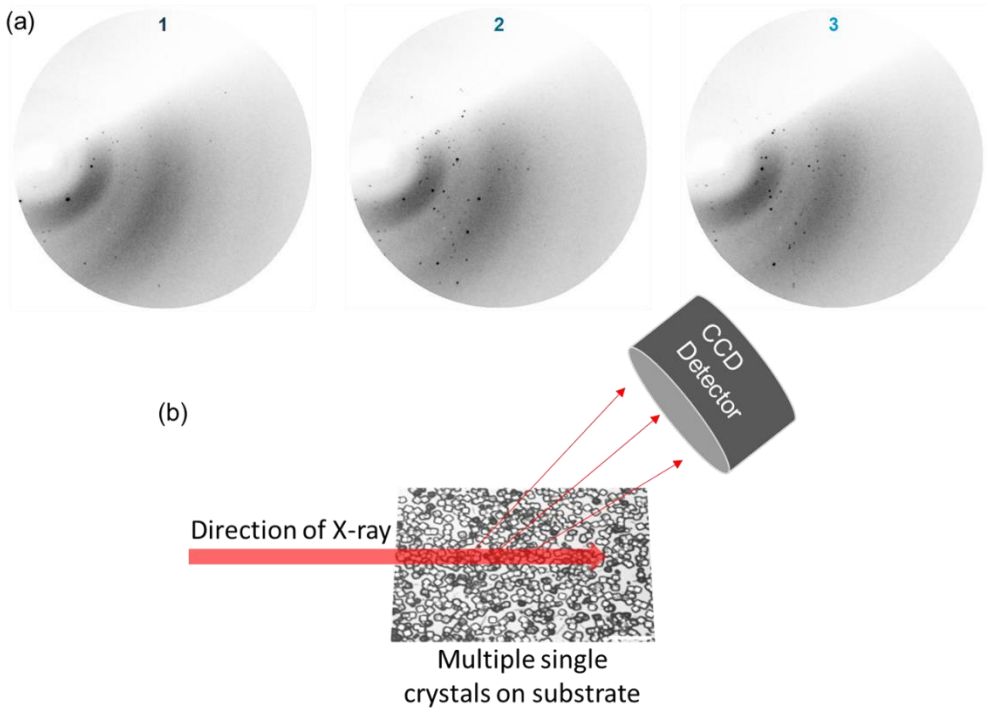

Figure S5. (a) Single crystal X-ray diffraction patterns collected from three different positions. Dark spots indicate the Bragg reflections from randomly oriented single crystals on substrates. (b) Illustration of the measurement setup. As there are multiple crystals with various orientations, multiple reflection spots were observed.

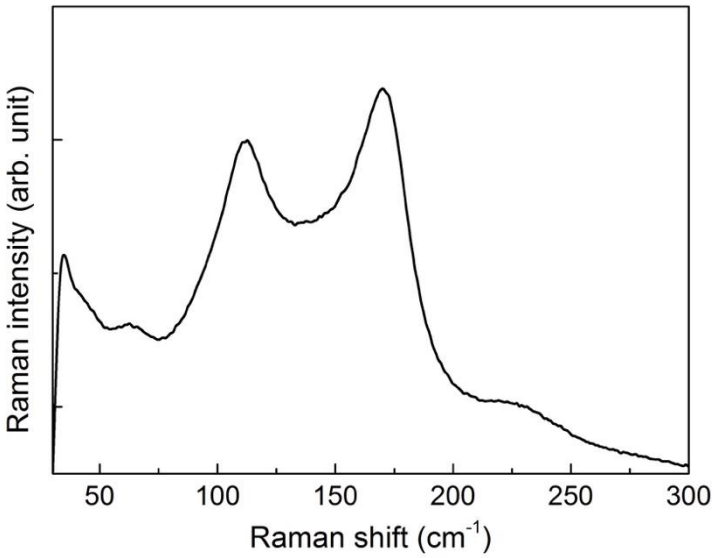

Figure S6. Raman spectrum of δ-phase FAPI. After the FAPI synthesis, the sample was left in air for a week to let α-phase convert to non-perovskite δ-phase.

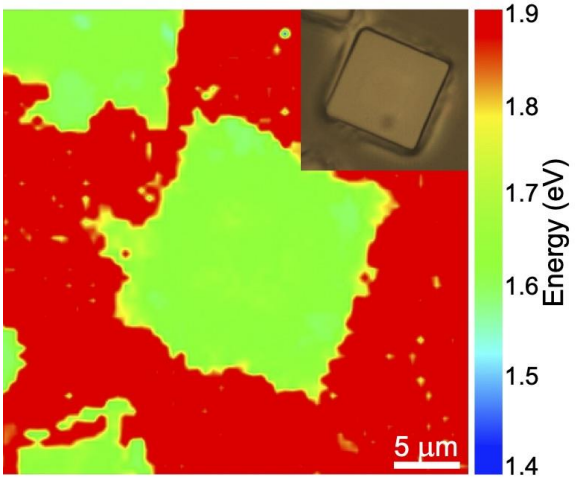

Figure S7. PL maximum energy position mapping for one-step FAPI crystals on ITO substrate. Figure inset shows the optical micrograph of the corresponding area.

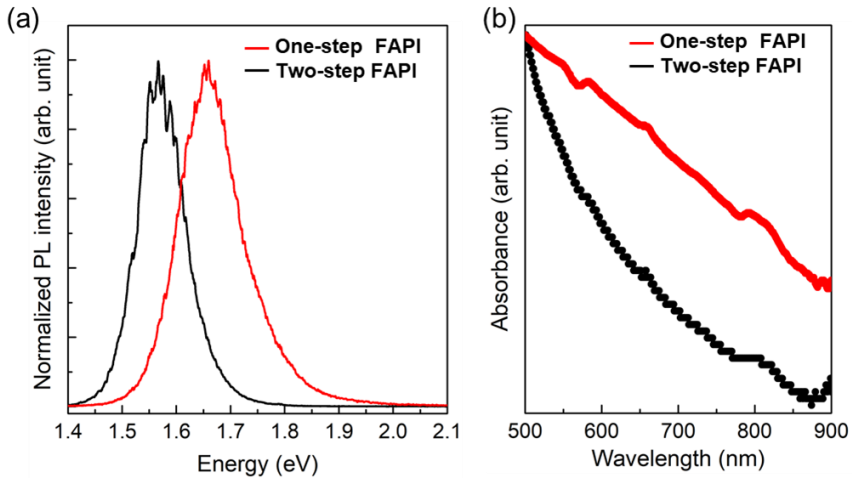

Figure S8. Comparison of PL (a) and absorbance (b) spectra of one-step FAPI and two-step FAPI.

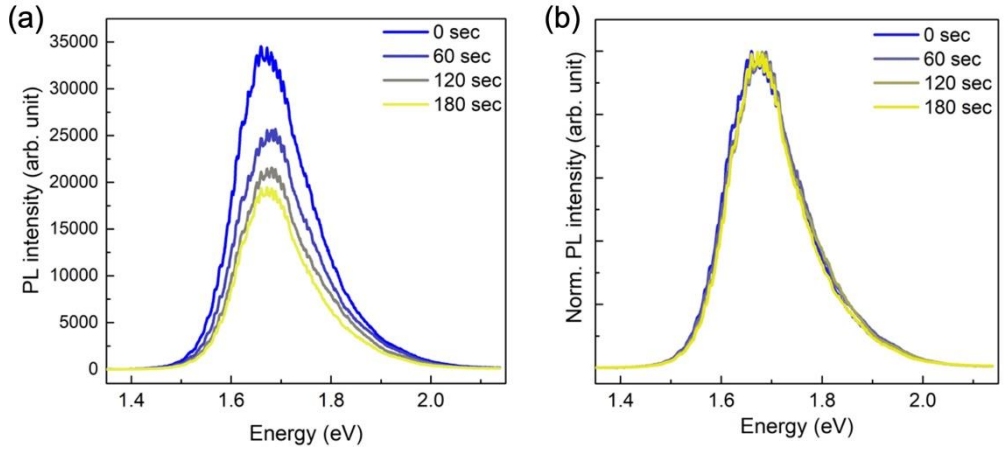

Figure S9. (a) Time dependent PL spectra of one-step FAPI. (b) After 3 minutes of continuous excitation, PL did not show blue shift, indicating that lattice heating is not the origin of the observed PL blue shift.

Reference

1 K. Momma and F. Izumi, *J. Appl. Crystallogr.*, 2011, **44**, 1272–1276.