

Supplementary Materials for

CH₃NH₃PbI₃ perovskites: Ferroelasticity revealed

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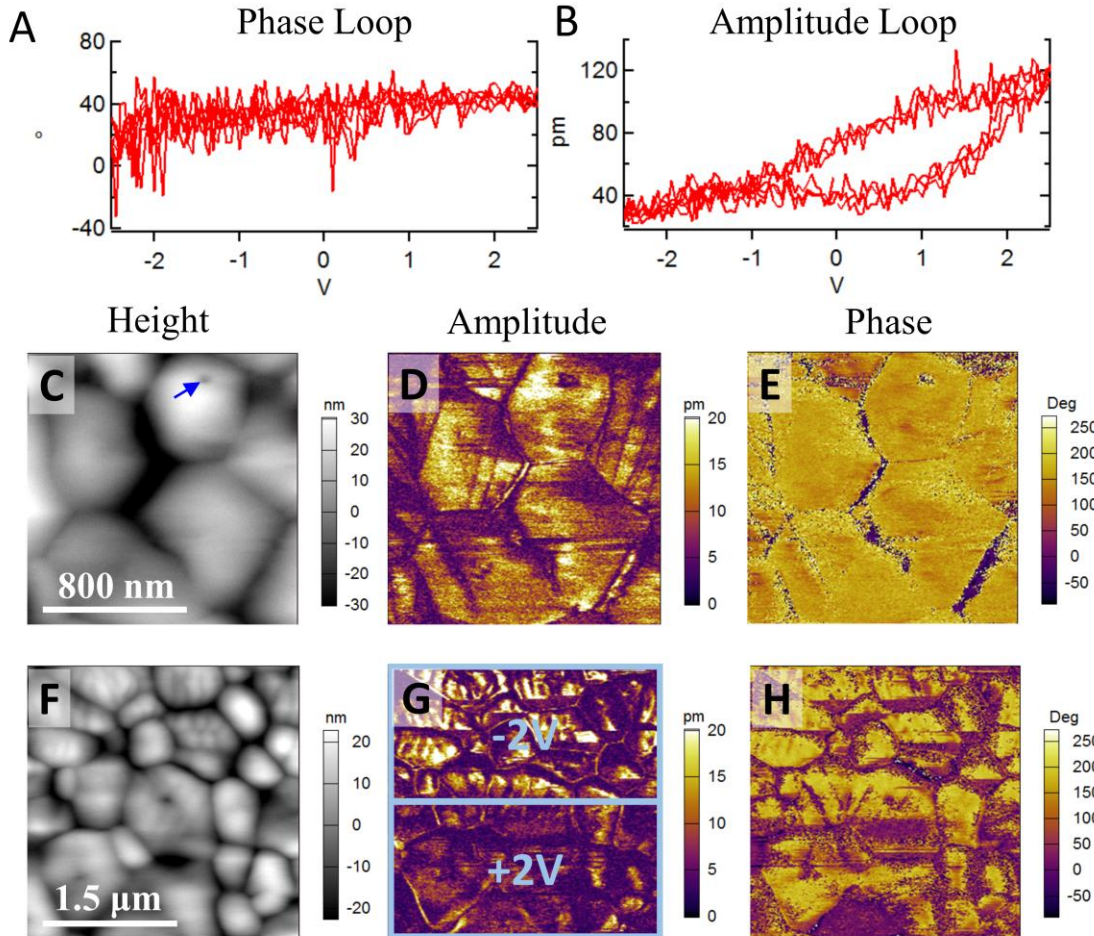


fig. S1. PFM measurements on sample A1 do not show evidence of ferroelectric behavior. (A and B) phase and amplitude hysteresis loops measured in the location indicated by the blue arrow in panel (C) by applying voltage locally with the PFM tip. The constant value of phase loop indicates no polarization switching occurred i.e. no ferroelectric behavior is detected. The applied DC electric bias only cause redistribution of charged carriers that produces the asymmetric electromechanical strain under positive and negative biases as seen in the amplitude loop. Because the ± 2.5 V applied bias has caused local degradation of the film in the position indicated by the arrow, the DC bias applied to sample for the subsequent measurements was always kept below 2.5 V. (C to E) Topography and PFM amplitude and phase images after the hysteresis measurement. (F to H) Topography and PFM amplitude and phase images obtained after poling the sample with -2 V (top half images) and $+2$ V (bottom half images) DC bias applied to the sample via scanning using the biased PFM tip. There is no clear contrast between the regions poled by positive and negative biases.

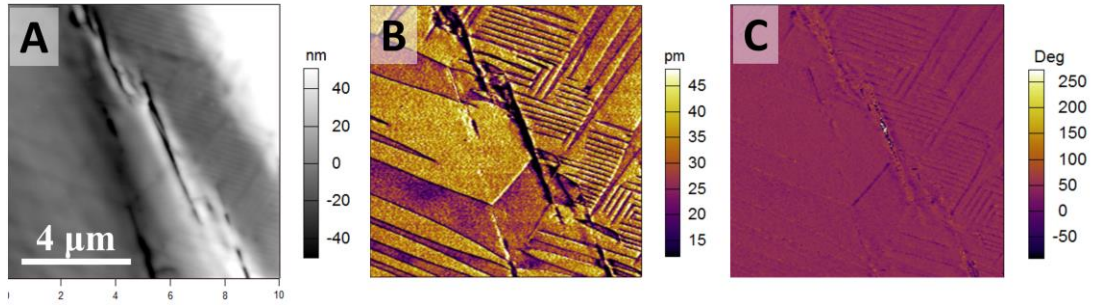


fig. S2. Representative PFM images showing strong amplitude contrast and very weak phase contrast. (A to C) Topography (A) and corresponding amplitude (B) and phase (C) images of in *Sample B1*. Strong amplitude contrast and very weak phase contrast indicate absence of ferroelectric domains in the MAPbI₃ films.

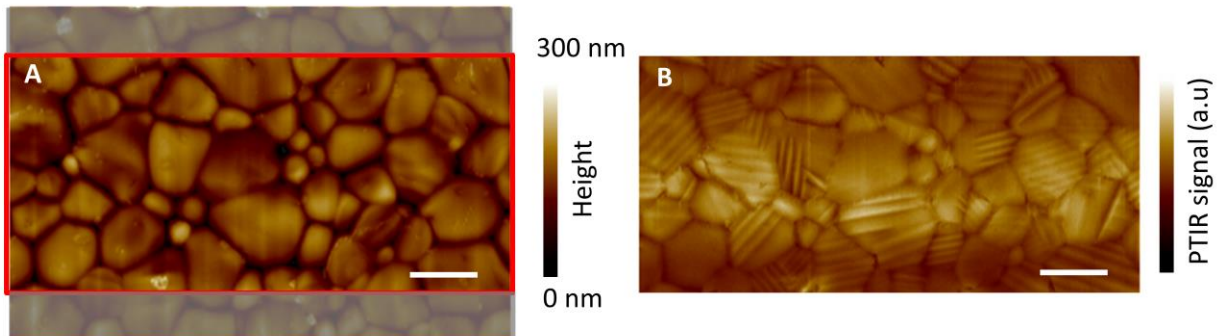


fig. S3. Observation of ferroelastic domains by PTIR. (A) *Sample A2* AFM topography image showing MAPbI₃ in between the electrodes (red box) and the MAPbI₃ covered electrodes (semitransparent gray areas). The red box defines the same area illustrated in Fig. 5 of the main text. (B) PTIR image of CH₃ asymmetric deformation of the methyl ammonium ion (1468 cm^{-1}) of the area defined by the red box in panel a (Same image in Fig. 5). All scale bars are $2\text{ }\mu\text{m}$.

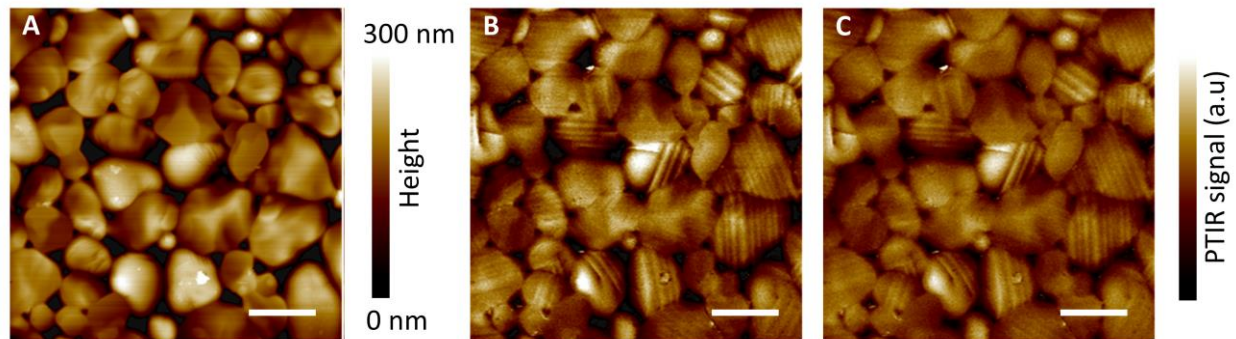


fig. S4. Observation of ferroelastic domains by PTIR with s- and p-polarization. (A) AFM topography image of the *Sample A2* (area away from the electrodes) and corresponding PTIR absorption maps recorded by illuminating the sample at 1468 cm^{-1} (CH_3 asymmetric deformation of the methyl ammonium ion) with (B) s-polarized light (light polarization in the sample plane), and (C) with p-polarized (light polarization with components in the sample plane and out of plane). All scale bars are $3.0\ \mu\text{m}$.