

*Supporting Information for*

**Solution Growth of Single Crystal Methylammonium Lead  
Halide Perovskite Nanostructures for Optoelectronic and  
Photovoltaic Applications**

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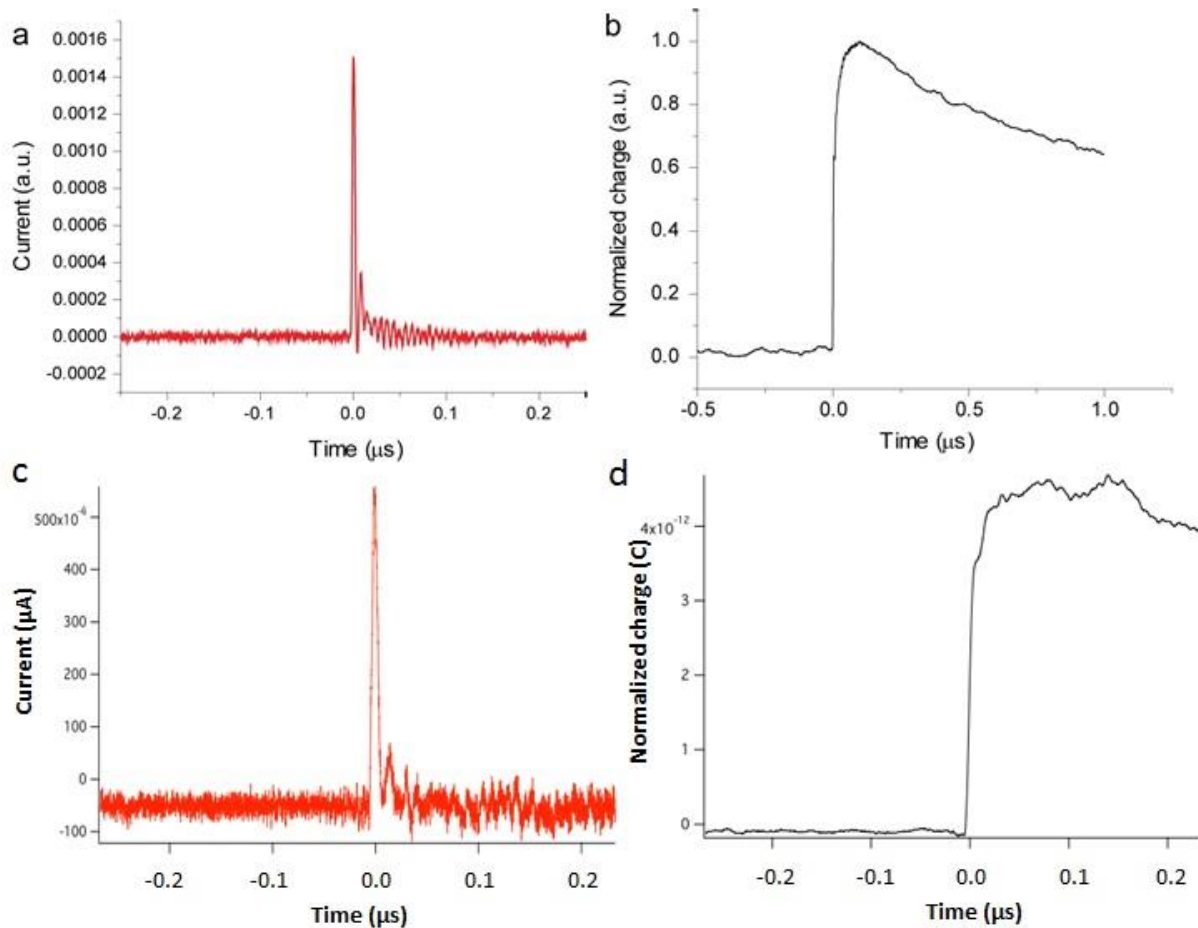


Figure S1. Time-resolved surface photoresponse (TR-SPR) measurements of MAPbI<sub>3</sub> nanostructures (a) current versus time, (b) integrated charge versus time, and bulk thin film (c) current versus time, (d) integrated charge versus time. The positive sign of the signal observed in the SPR measurements confirms that these single crystal MAPbI<sub>3</sub> nanostructures are *n*-type semiconductors, which is similar to the *n*-type doping observed for the polycrystalline MAPbI<sub>3</sub> thin film.

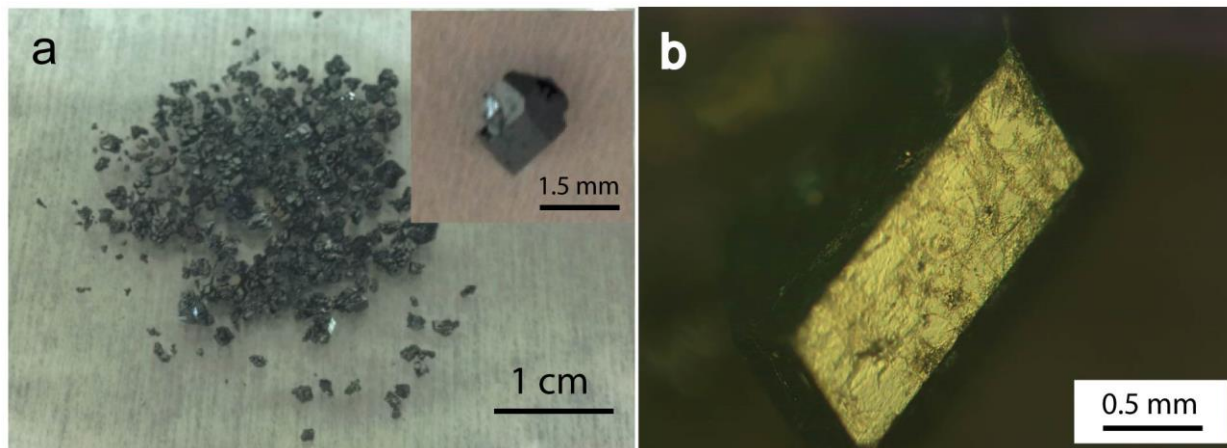


Figure S2. (a) Optical images of bulk MAPbI<sub>3</sub> crystals. (b) Dark-field image of a MAPbI<sub>3</sub> single crystal.

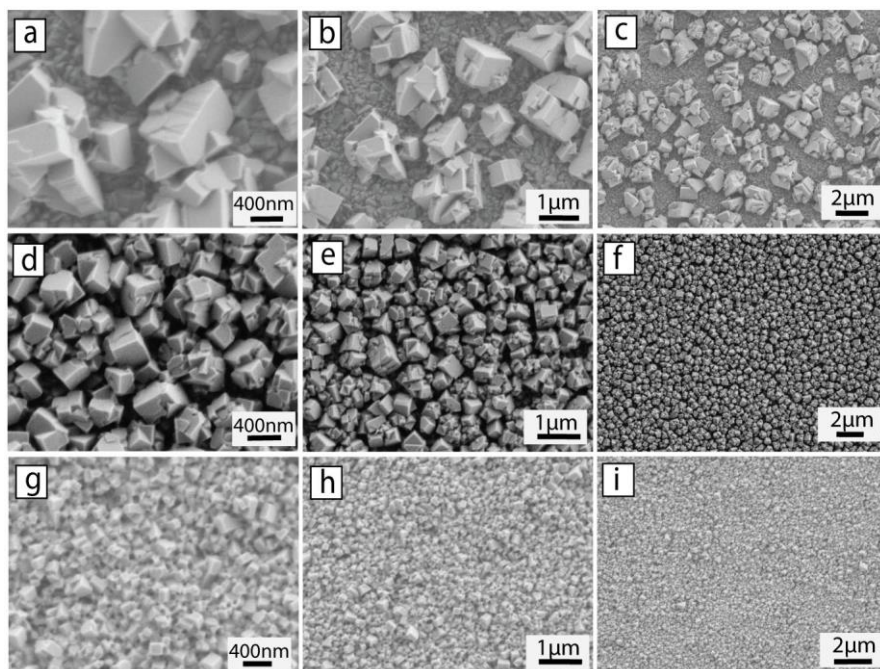


Figure S3. More SEM images of polycrystalline nanostructured MAPbI<sub>3</sub> films converted at low concentration of MAI at, (a-c) 5 mg/mL, (d-f) 7.5 mg/mL, and (g-i) 10 mg/mL. The time of conversion was 2 min.

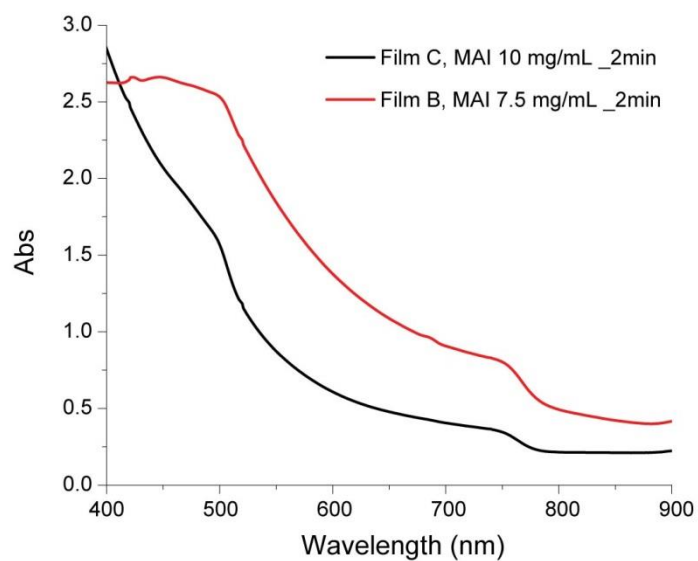


Figure S4. Visible absorption spectra of polycrystalline nanostructured MAPbI<sub>3</sub> film B and film C shown in Figure 4 of the main text.

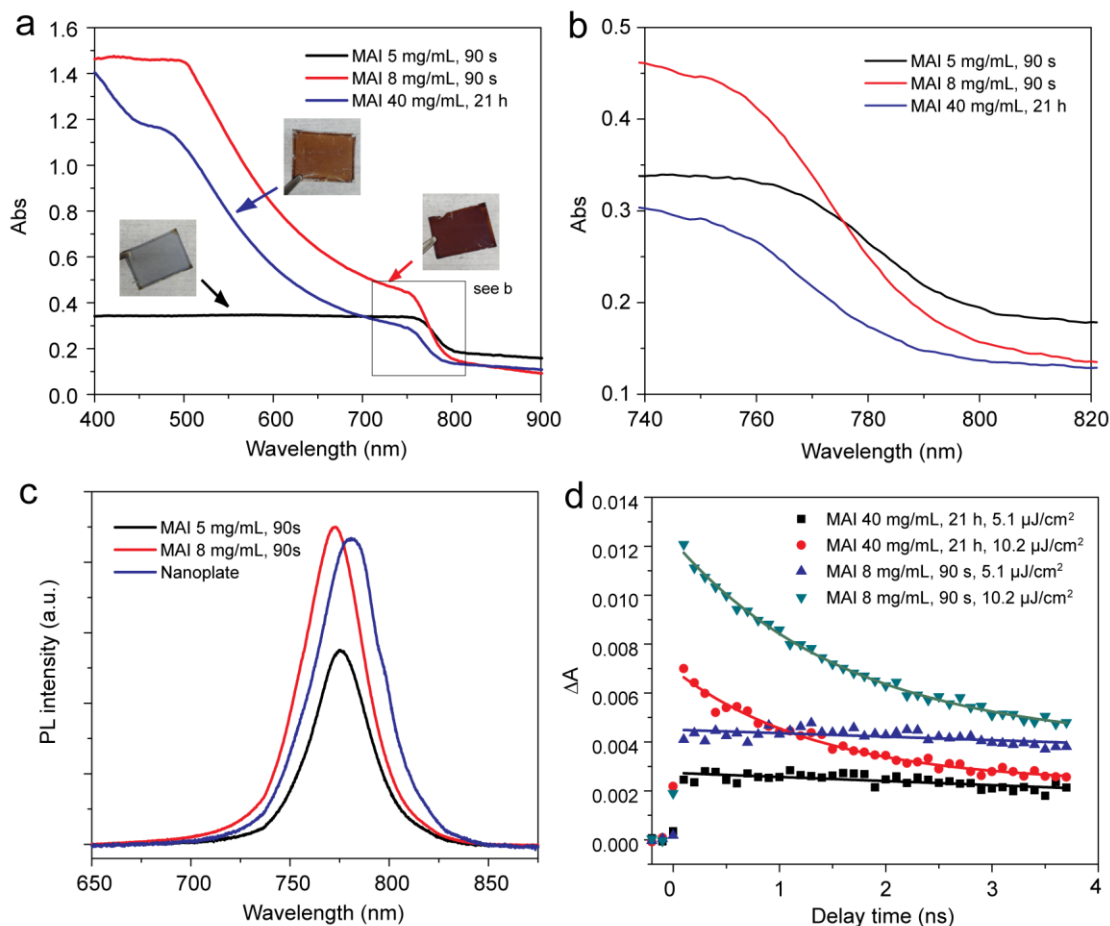


Figure S5. (a) Absorption spectra of the nanostructures grown at the MAI concentration of 5 mg/mL and reaction time of 90 s (dark line), MAI concentration of 8 mg/mL and reaction time of 90 s (red line), and MAI concentration of 40 mg/mL and reaction time of 21 h, which lead to nanoplates and nanowires shown in the main text (blue line). The lead iodide films were prepared on glass slides. (b) shows the details in the rectangular box in panel a. (c) The corresponding confocal microscopy photoluminescence spectra of these three samples. (d) Transient absorption spectroscopy showing the carrier decay dynamics of MAPbI<sub>3</sub> perovskite nanostructures (8 mg/mL and 40 mg/mL samples) at two different pump power densities. Note that the 5 mg/mL synthesis led to large but sparse cubes (Figure 4a in the main text), therefore

the overall light absorption is not very strong. Also because such sample scatters light severely, it was not possible to collect reliable transient spectroscopy data.

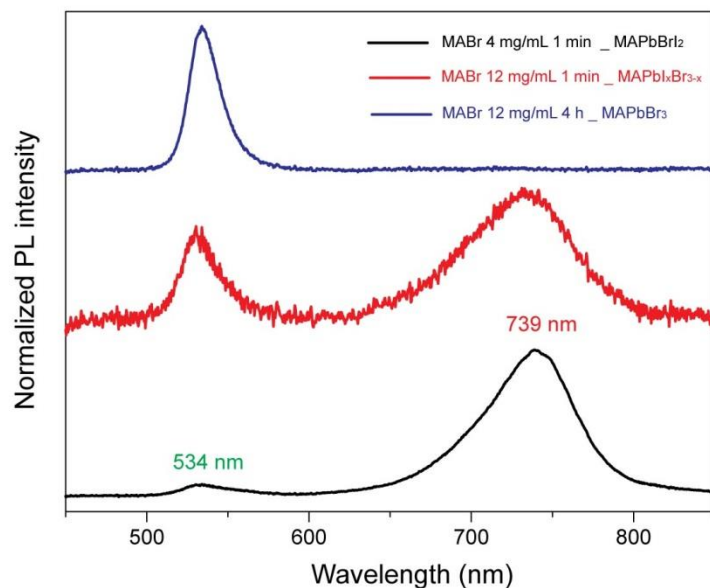


Figure S6. Confocal PL spectra of as-grown perovskite nanostructures using  $\text{PbI}_2$  film as precursor and 4 mg/mL MABr solution with a reaction time of 1 min (black curve), 12 mg/mL MABr solution with a reaction time of 1 min (red curve), and 12 mg/mL MABr solution with a reaction time of 4 h (blue curve). The films were excited by a 442 nm laser source. The black curve showing strong PL emission peak located at 739 nm that comes from the  $\text{MAPbBr}_2\text{I}$  phase. However, the minor 534 nm peak also indicates trace amount of  $\text{MAPbBr}_3$  is also formed. The red curve shows  $\text{MAPbBrI}_2$  phase is also presents in the film, but PXRD (Figure 6a) confirms the film is more likely to be  $\text{MAPbI}_x\text{Br}_{3-x}$ . The blue curve showing emission at 535 nm confirms pure  $\text{MAPbBr}_3$  phase.

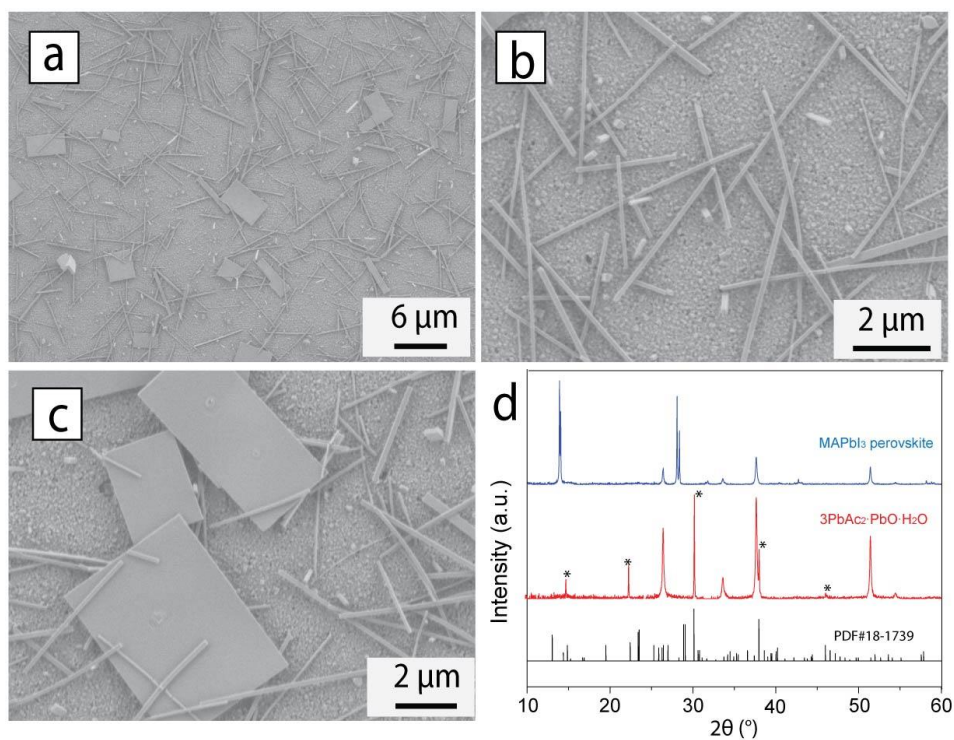


Figure S7. Structural characterizations of the  $\text{MAPbI}_3$  nanostructures grown using  $\text{PbAc}_2$  precursor and 40 mg/mL MAI/IPA solution. (a–c) SEM images of  $\text{MAPbI}_3$  NWs, NRs and nanoplates formed after 1 h growth time. (e) PXRD patterns of the as-grown perovskite film and the resulting film prepared by spin coating  $\text{PbAc}_2$  aqueous solution.