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# Supplementary Information for

## Evaluating the role of phenethylamine iodide as a novel anti-solvent for enhancing performance of inverted planar perovskite solar cells

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## Experimental section

**Materials:** PTAA was purchased from Solaris and $PC_{70}CB$ from Solenne BV; BCP purchased from Sigma-Aldrich. The materials for perovskite layers and devices fabrication were: $PbI_2$ and $PbBr_2$ (99.99% purity) bought from TCI, FAI and MABr were purchased from GreatCell Solar. CsI (99.999%) was from Alfa Aesar and RbI (99.8%) obtained from Sigma-Aldrich.

**Solvents:** *Dimethylformamide (DMF) anhydrous 99.8%, Dimethyl sulfoxide* (*DMSO*) anhydrous ≥ 99.9%, Butanol 99.5% and CB 99.8% were obtained from Sigma-Aldrich. Toluene 99.7% and Isopropanol (IPA) >99.8% purchased from Honeywell Research Chemicals.

**Device fabrication:** ITO/glass patterned substrates where used, purchased from Naranjo Substrates ( ITO thickness ~ 100 nm and a sheet resistance of ~20 Ω/sq). The cleaning procedure of the substrates included soap, deionized water, acetone, and isopropanol under ultrasonication. Afterward, the substrates transfered to a nitrogen filled glovebox and treated with ozone for 15 minutes. 2 mg $ml^{-1}$ of PTAA in Toluene was used as the hole transport layer and spin coated at 6000 rpm for 30 sec. After spinning, the sample was placed on a hot plate for annealing at 110$^o$ C for 10 min. The perovskite precursor solution (1.25 M) was dissolved in 4:1 V/V DMF/DMSO according to a formula of $Rb_{0.04}Cs_{0.05}[(FA_{0.85}MA_{0.15})]_{0.9}Pb(I_{0.85}Br_{0.15})_3$. CsI and RbI solutions of 1.5 M prepared using DMSO and 4:1 V/V DMF/DMSO solvents, respectively and added into the perovskite precursor solution. The RbCsMAFA perovskite layer was deposited on top of PTAA by a one-step dynamic spin-coating procedure using 6000 rpm for 45 sec. The anti-solvent (Chlorobenze anhydrous 200µL for the control devices or 1 mg $ml^{-1}$ PEAI in butanol) was dropped 20 sec before the end of the spinning. Next, the sample was annealed at 100 °C for 45 min. Subsequently, $PC_{70}BM$ which was used as an electron transport layer with a concentration of 20 mg $ml^{-1}$ of anhydrous CB spin-coated for 60 sec at 1000 rpm on the perovskite surface for the control devices. In the case of post-deposited passivated films, PEAI (1 mg $ml^{-1}$ in butanol) was spin coated on top of the annealed perovskite

film and before the $PC_{70}BM$ deposition step. Finally, the BCP interlayer with a concentration of 0.5 mg $ml^{-1}$ in extra dry IPA was further spin-coated at 4000 rpm for 45 sec. The device fabrication was completed by depositing 100 nm Ag by thermal evaporation.

**Perovskite film characterization:** The XRD spectra was obtained using a D/MAX-2000 X-ray diffractometer with a monochromated Cu K α irradiation ( λ = 1.5418 Å) at a scan rate of 4 ° $min^{-1}$. The topography of films was investigated using an atomic force microscope (AFM) (XE7 Park Systems) operating in tapping mode. Steady state PL and transient photovoltage measurements were performed on a commercial transient module system (ARKEO, Cicci research s.r.l.). For the PL measurements the films were excited by a green (532 nm) laser at 45° of incidence with a 1 mm spot diameter. The water contact angle was measured by a contact angle goniometer from Ossila (measurement accuracy ± $1^{o}$). Steady-state J-V curves were obtained in a glove box (MBRAUN) under standard simulated AM1.5G irradiation (100 mW $cm^{-2}$) at a scan rate of 10 $mVs^{-1}$ using a Solar Cell I-V Test System from Ossila. The EQE was measured using a commercial system from Enlitech.

## Characterization

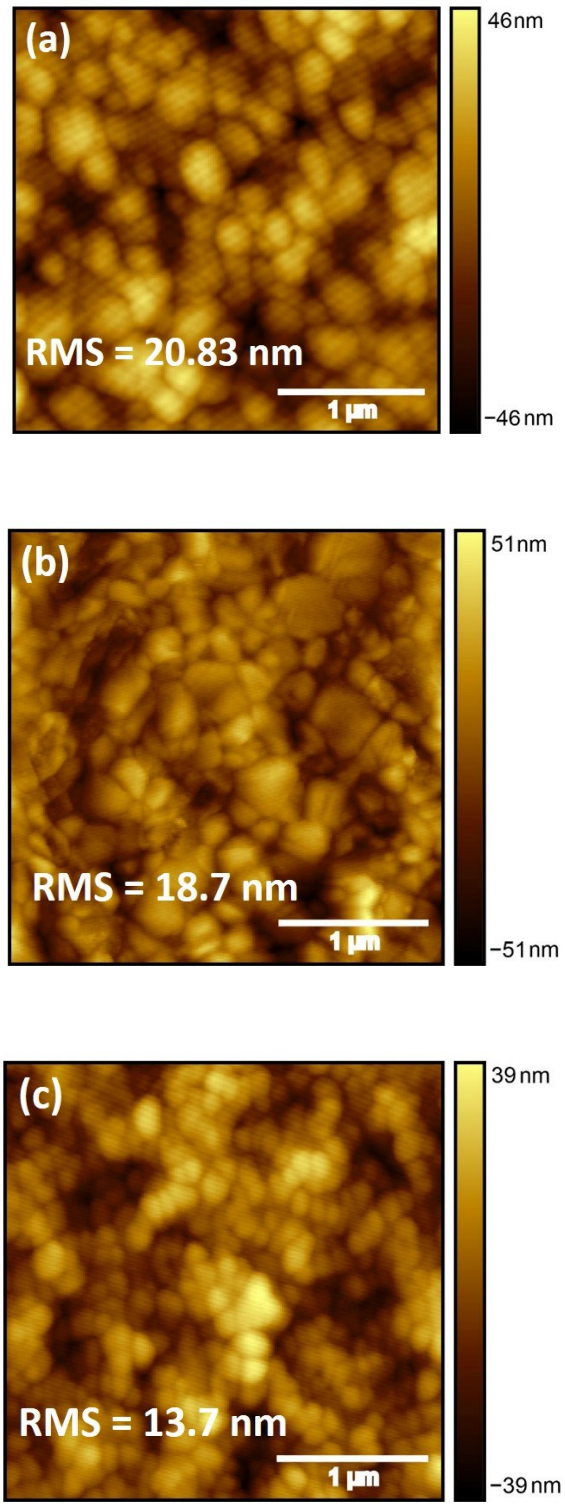


**Figure S1.** Atomic force microscopy images from the $R_b$CsFAMA perovskite for a) control film, b) film with post-deposited PEAI layer and c) film with PEAI anti-solvent.

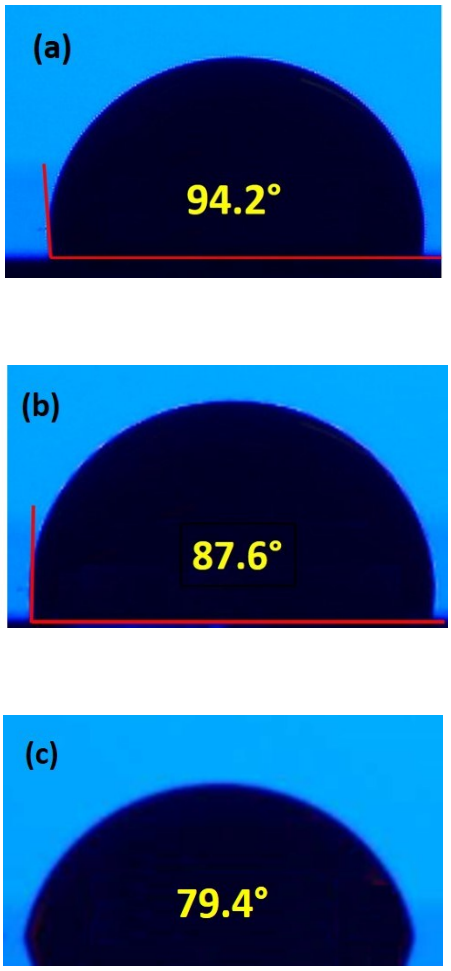


**Figure S2.** Contact angle tests for perovskite films with a) PEAI anti-solvent, b) PEAI layer and c) control, respectively.

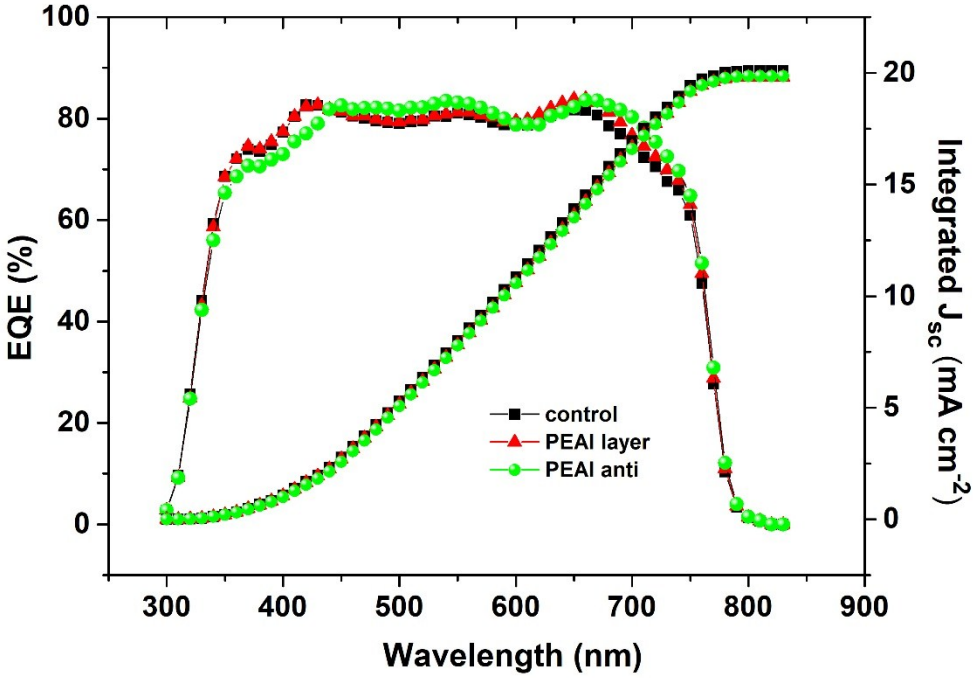


**Figure S3**. External quantum efficiency (EQE) spectra from the best obtained devices.

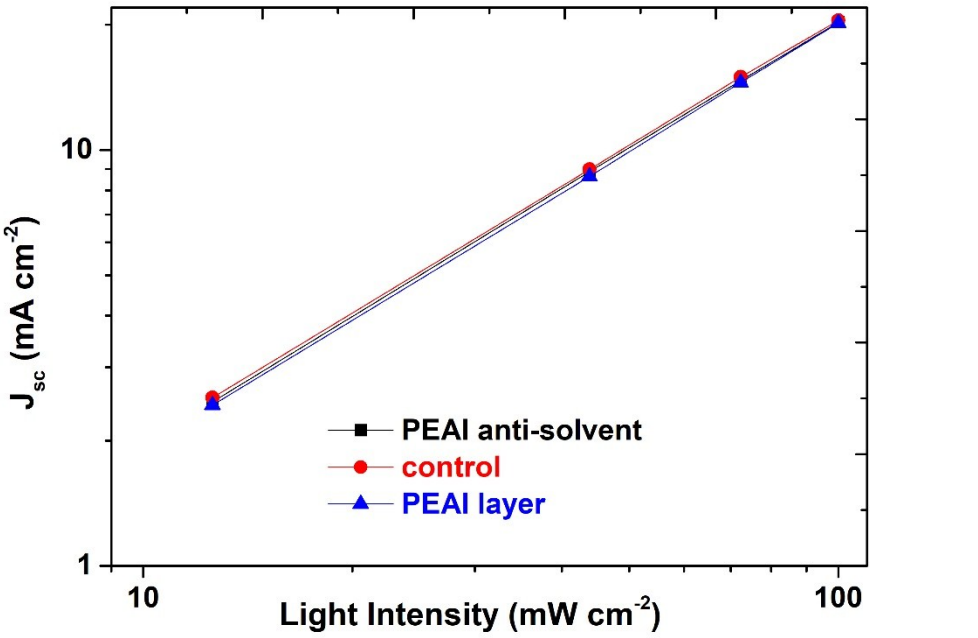


**Figure S4.** $J_{sc}$ as a function of light intensity for the $R_bC_sFAMA$ devices with and without PEAI treatment.