

Butanediammonium Salt Additives for Increasing Functional and Operando Stability of Light-Harvesting Materials in Perovskite Solar Cells

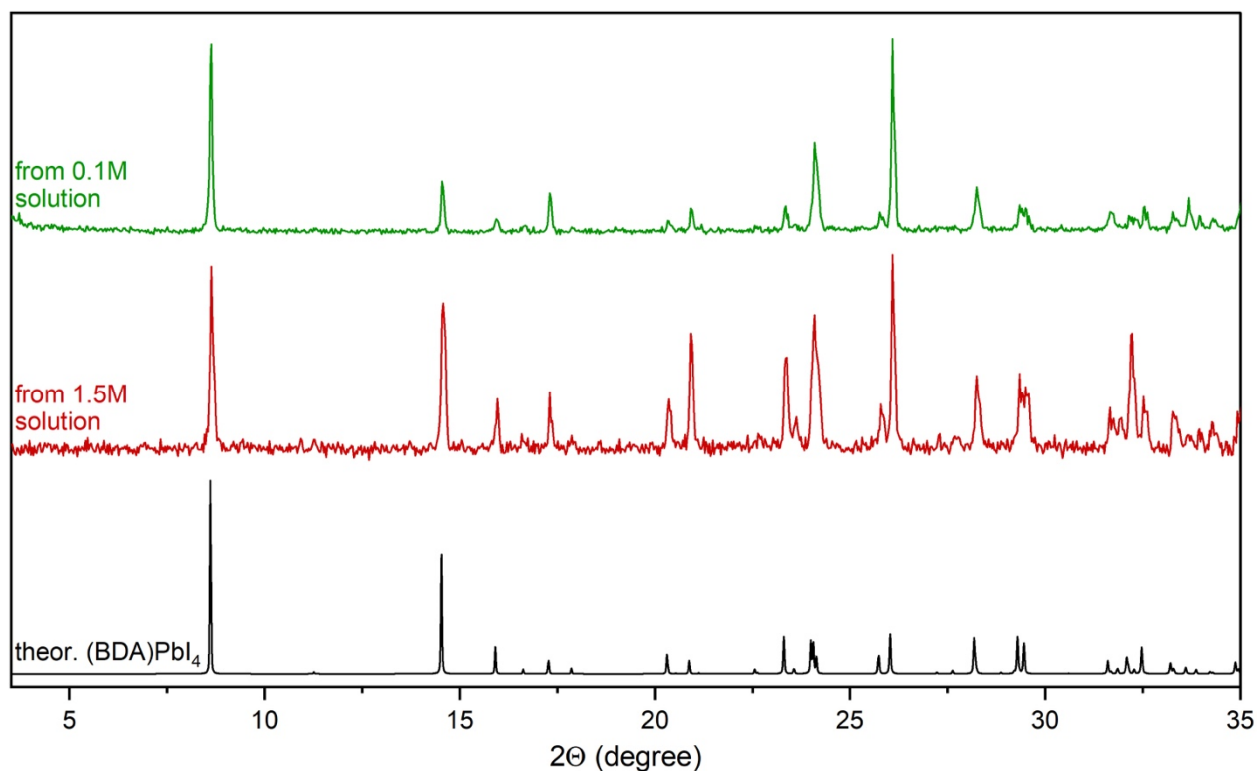


Figure S1. Powder XRD patterns of 2D perovskite crystals, prepared from 0.1M (green line) and 1.5M (red line) (BDA)(MA)Pb₂I₇ solutions. Black line corresponds to theoretical XRD pattern of (BDA)PbI₄ phase.

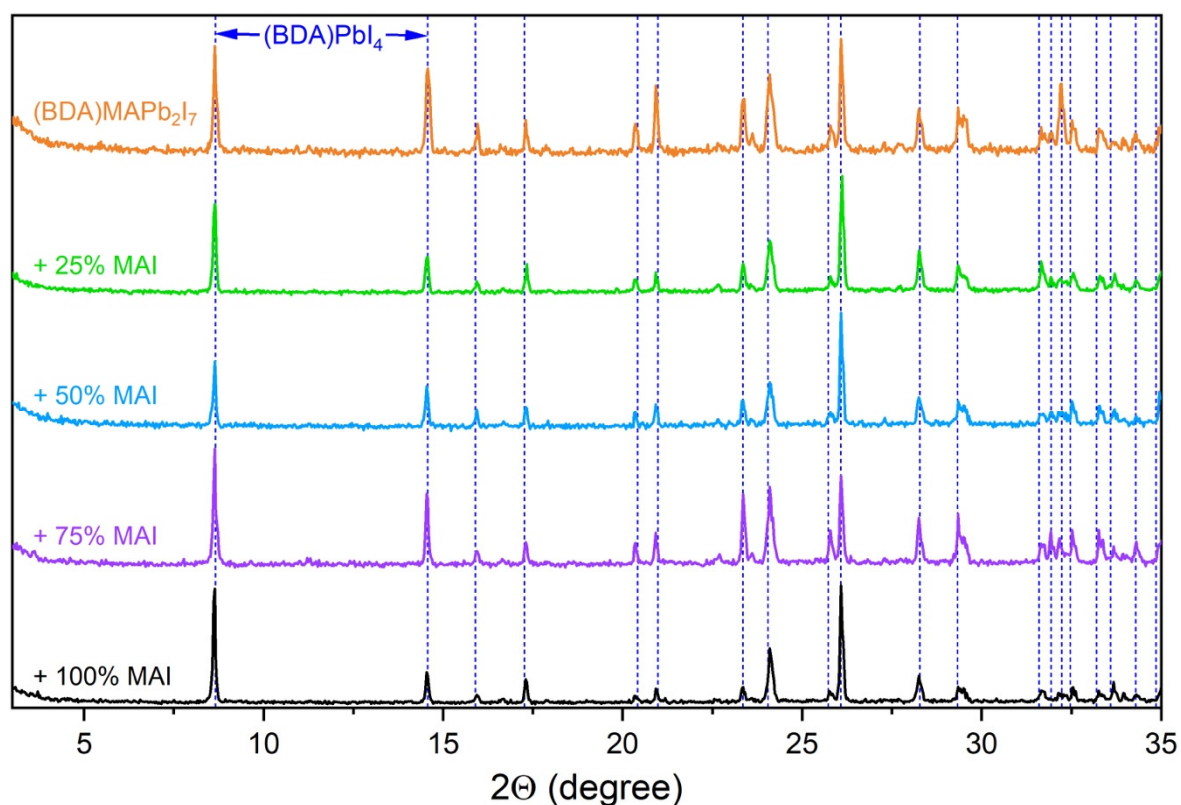


Figure S2. Powder XRD patterns of 2D perovskite crystals, prepared from stoichiometric (BDA)(MA)Pb₂I₇ solution (upper line) and from solutions with different excess of MAI, specified above each line. Vertical dashed lined correspond to the reflexes of (BDA)PbI₄ phase.

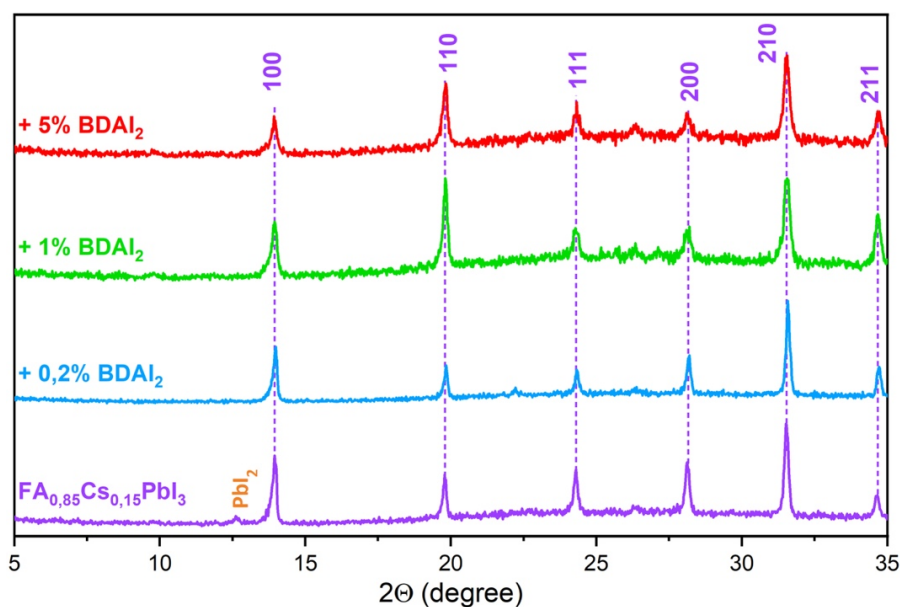


Figure S3. XRD patterns of FA_{0.85}Cs_{0.15}PbI₃ perovskite films with different BDAI₂ content.

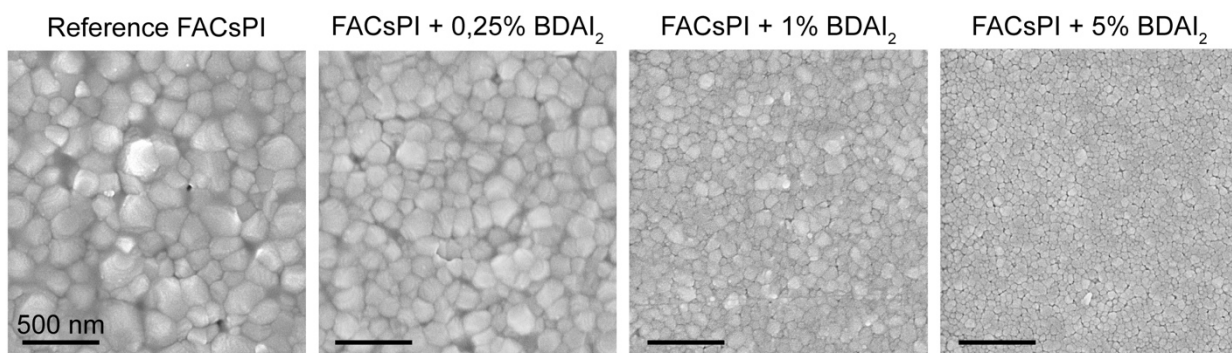


Figure S4. SEM images of FACsPI perovskite films with 0, 0.25, 1, and 5% BDAI₂ content.

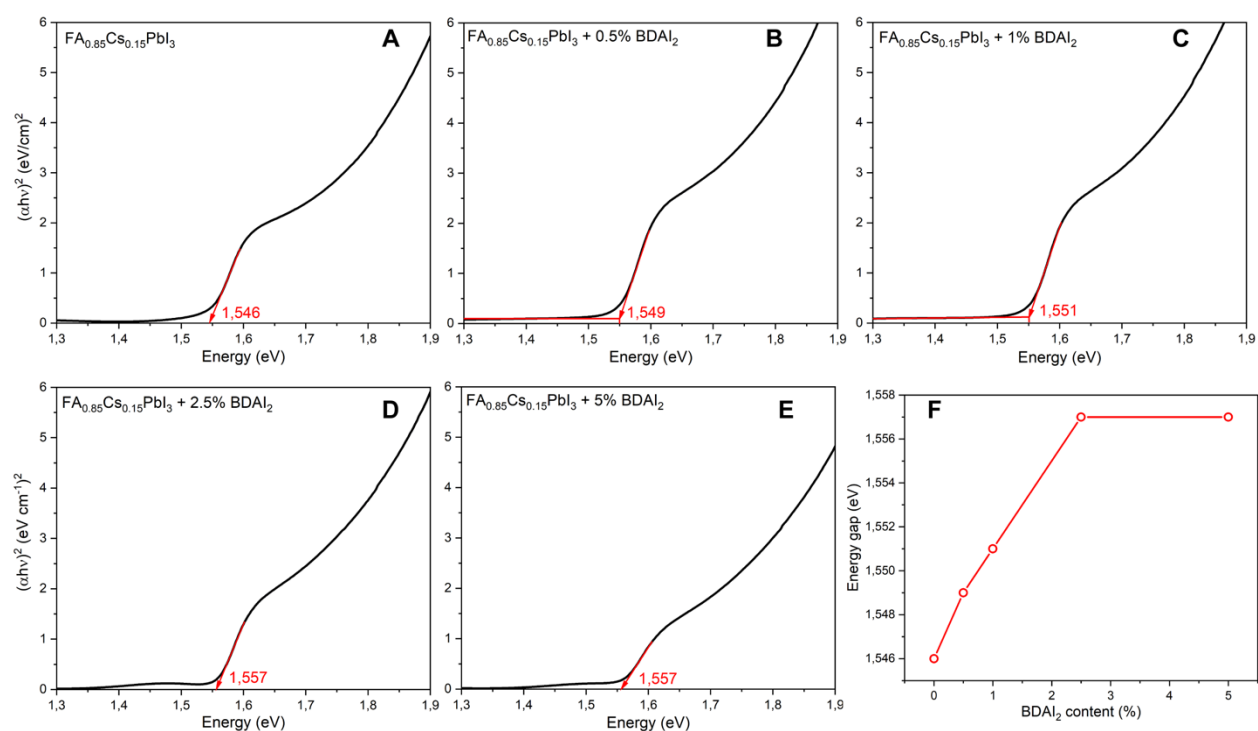


Figure S5. (A-E) Tauc plots of FA_{0.85}CS_{0.15}PbI₃ perovskite films with different BDAI₂ content. (F) Energy gap of FA_{0.85}CS_{0.15}PbI₃ perovskite as a function of BDAI₂ content, calculated from corresponding Tauc plots.

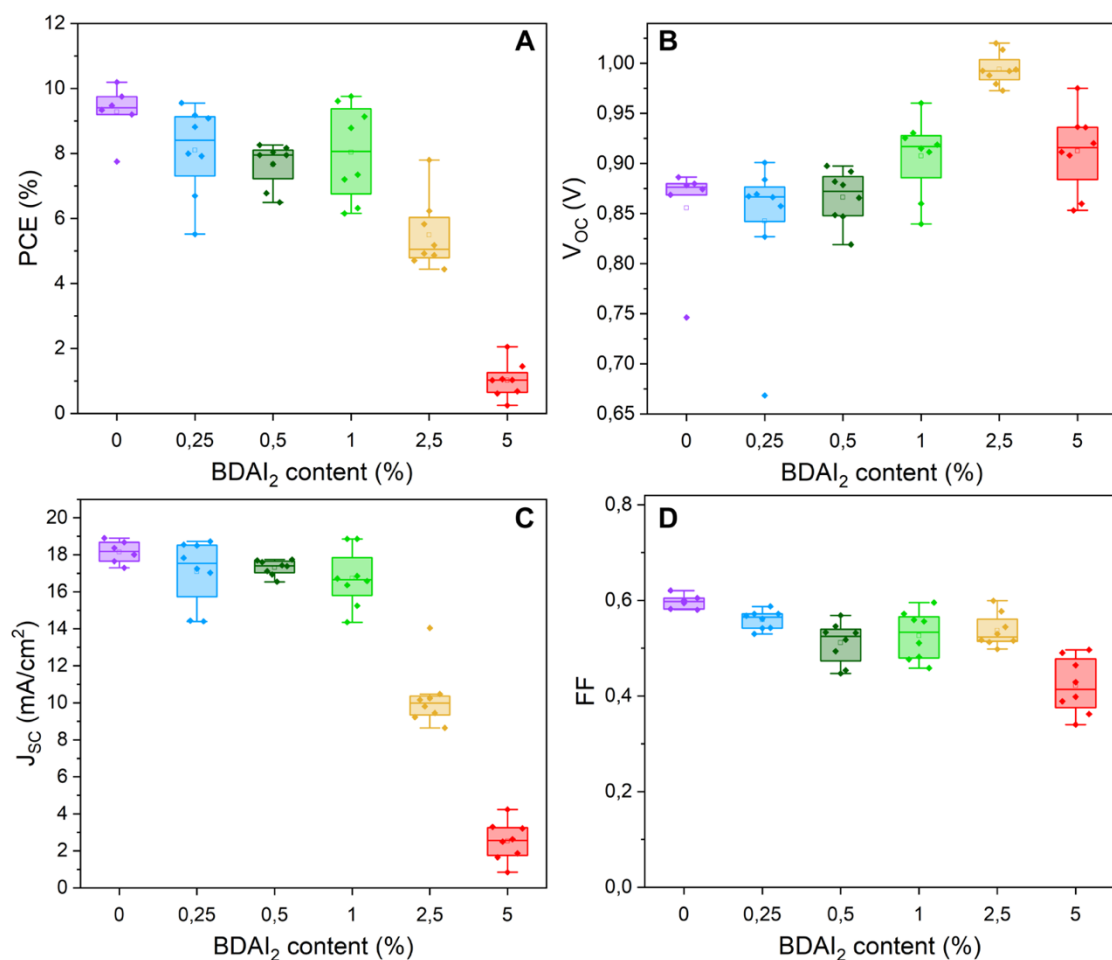


Figure S6. Distributions of operando parameters of PSCs based on FACsPI + $x\%$ BDAI₂ light-harvesting materials: PCE (A), V_{oc} (B), J_{sc} (C), and FF (D).

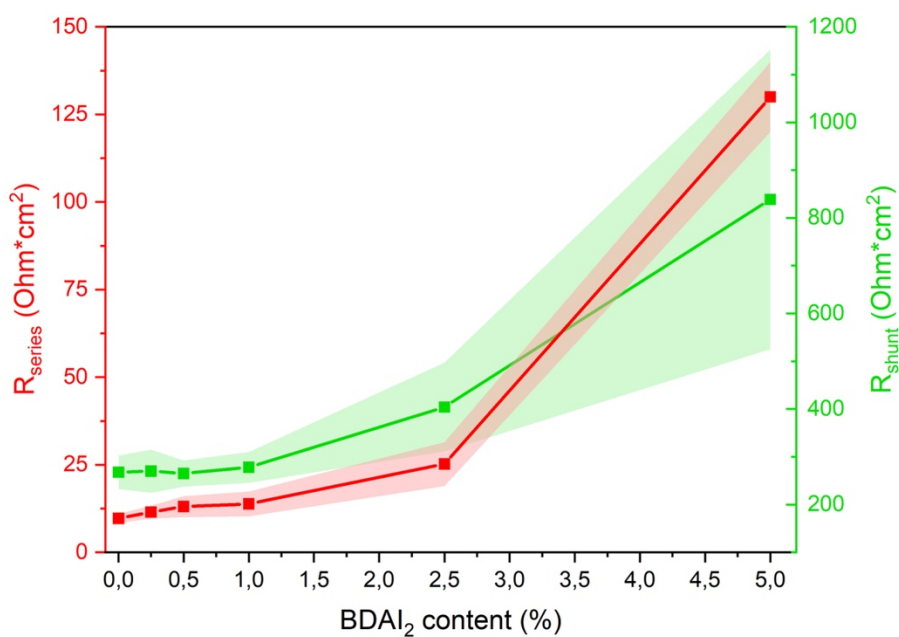


Figure S7. The dependence of series resistance (red) and shunt resistance (green) of PSCs on BDAI₂ content, estimated from quasi steady state J-V curves under 1 sun illumination.

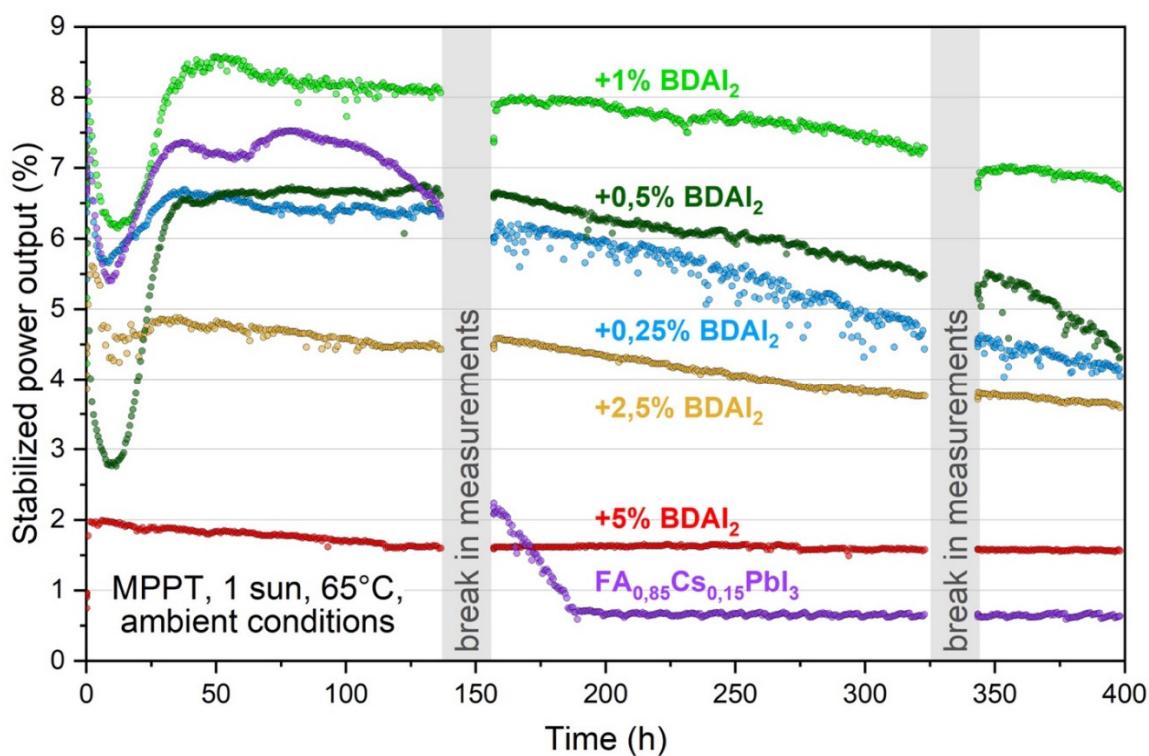


Figure S8. Stabilized power output of encapsulated perovskite solar cells with different BDAI₂ amounts under continuous 1 sun illumination, stabilized temperature 65°C, and ambient environment. Twice during the experiment SPO measurements were technically interrupted for several hours with preserved light and heat aging, PSCs during these periods were loaded close to MPP.

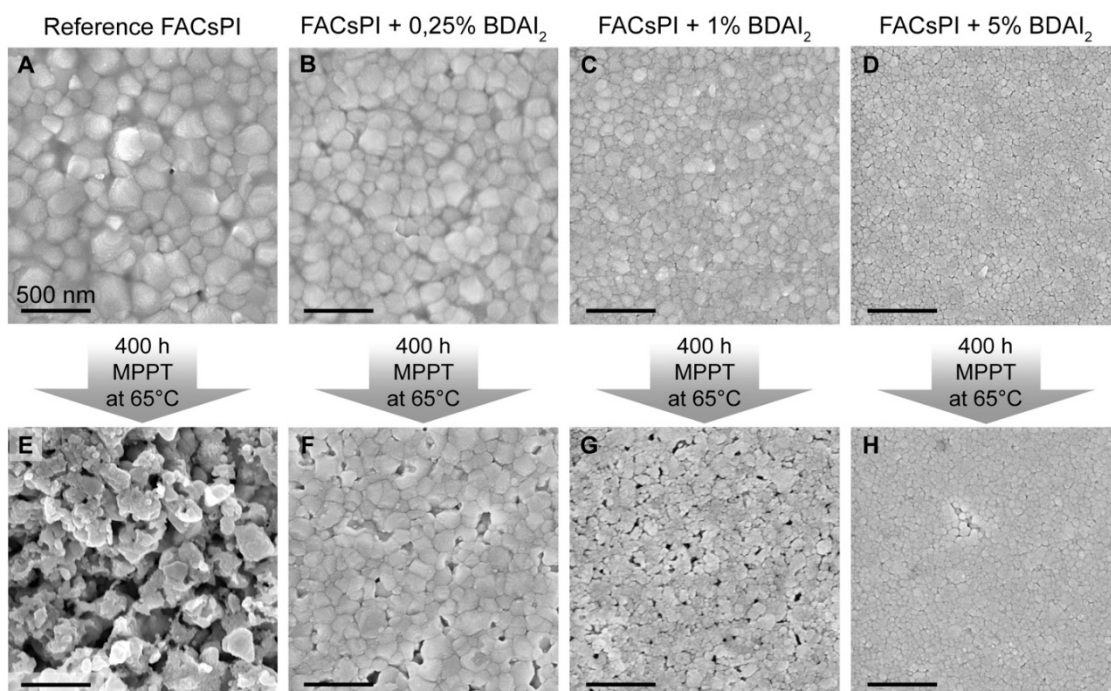


Figure S9. SEM images of four FACsPI perovskite films with different BDAI₂ content: 0% (A, E), 0.25% (B, F), 1% (C, G), and 5% (D, H) before (A-D) and after (E-H) 400 hours of MPPT under constant 1 sun illumination and 65°C. All scale bars are 500 nm.