Supporting Information

Two-dimensional inverted planar perovskite solar cells with efficiency over 15% via solvent and interface engineering

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Keywords: 2D perovskite, solvent engineering, interface engineering, formamide, PCP-Na

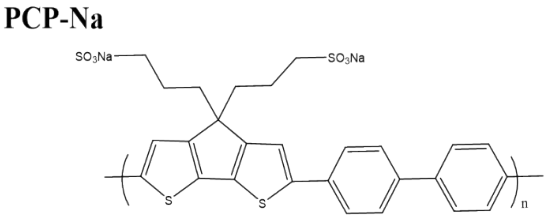

Figure S1. Chemical structure of PCP-Na.

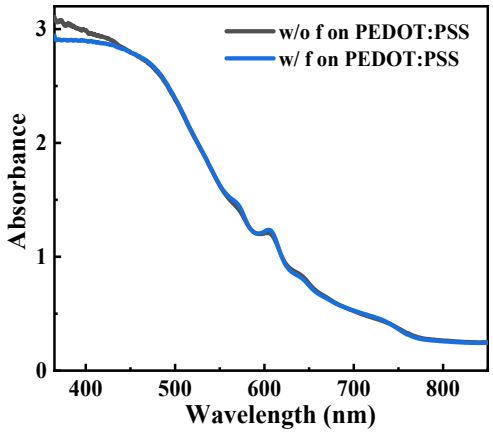

Figure S2. Absorption spectra of $(BA,GA)_2MA_4Pb_5I_{16}$ perovskite films with and without formamide adition on PEDOT:PSS substrate.

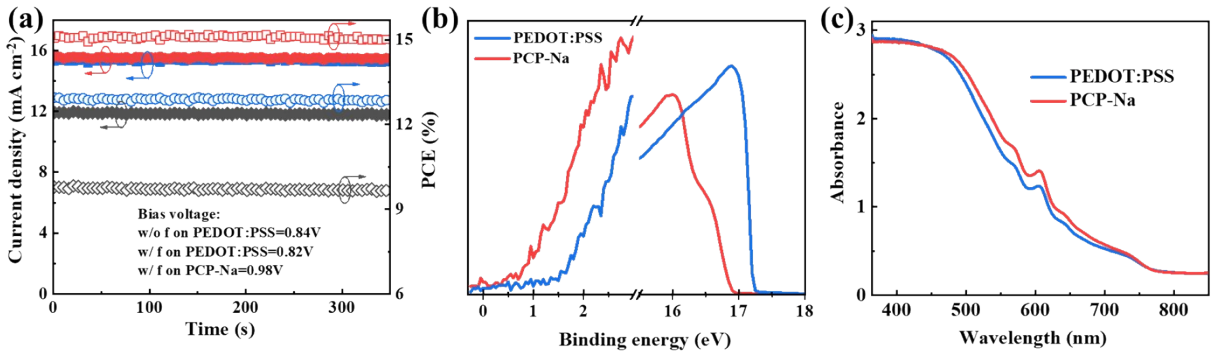

Figure S3. (a) Stabilized photocurrent measurement under 1 sun condition of the (BA, GA)$_2$MA$_4$Pb$_5$I$_{16}$ based PVSCs without or with formamide addition on different substrates. (b) The UPS spectra, (c) UV-Vis spectra of the (BA,GA)$_{2(}$MA)$_4$Pb$_5$I$_{16}$ perovskite films with formamide addition on different substrates.

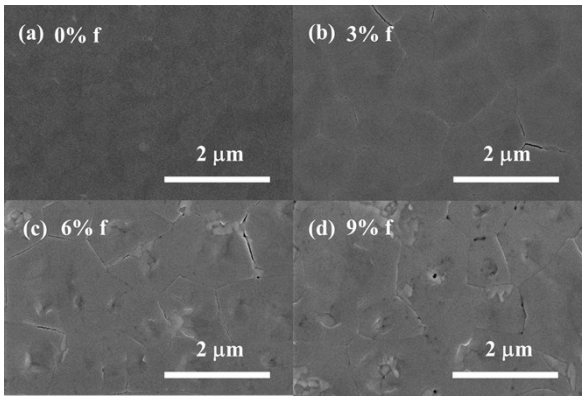

Figure S4. Top-view SEM images of (BA,GA)$_2$MA$_4$Pb$_5$I$_{16}$ perovskite films fabricated with different amounts of formamide on PEDOT:PSS substrate.

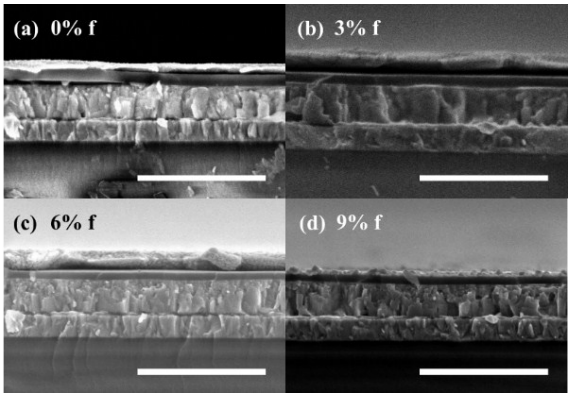

Figure S5. Cross-sectional SEM images of (BA,GA)$_2$MA$_4$Pb$_5$I$_{16}$ perovskite films fabricated with different amounts of formamide on PEDOT:PSS substrate. (The scale bar is 1 μm.)

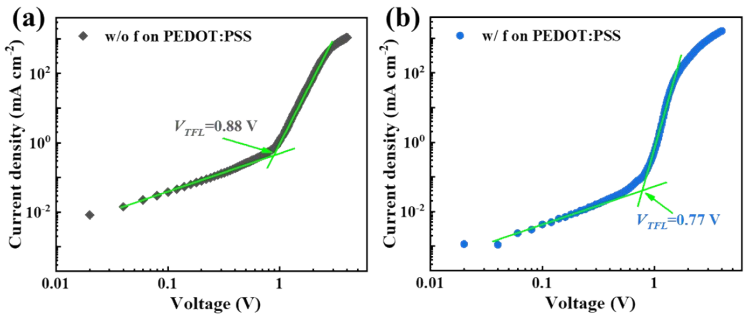

Figure S6. Dark current-voltage measurements of the electron-only devices for the $(BA,GA)_2MA_4Pb_5I_{16}$ perovskite with and without formamide addition. The defect density could be calculated by equation $N_{defects}= 2\varepsilon\varepsilon_0V_{TFL}/eL^2$ (*Science* **2015**, 347, 967) (ε and ε_0 are the dielectric constants of perovskite and the vacuum permittivity, respectively, L is the thickness of the obtained perovskite film, about 300 nm in this study, and e is the elementary charge). When ε is constant, $N_{defects}$ is in direct proportion to $V_{TFL.}$ Therefore, the decrease of V_{TFL} indicating the reduced electron trap-state density.

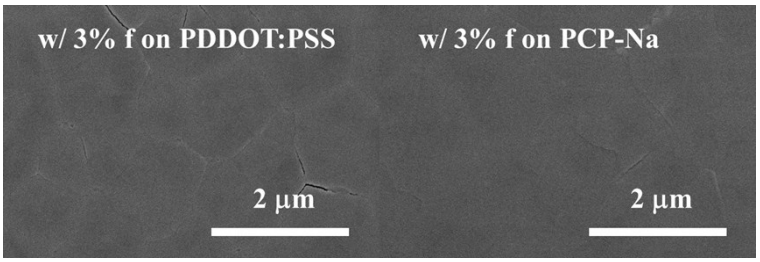

Figure S7. Top-view SEM images of $(BA,GA)_2MA_4Pb_5I_{16}$ perovskite films fabricated with 3% formamide addition on (a) PEDOT:PSS and (b) PCP-Na substrate.

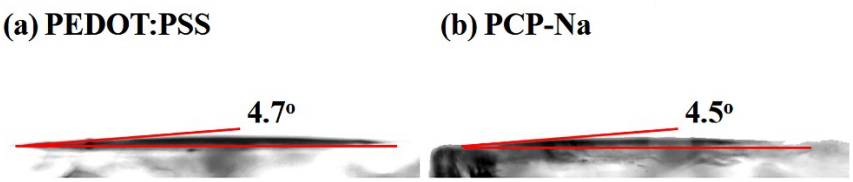

Figure S8. Water contact angle of (a) PEDOT:PSS and (b) PCP-Na substrates.

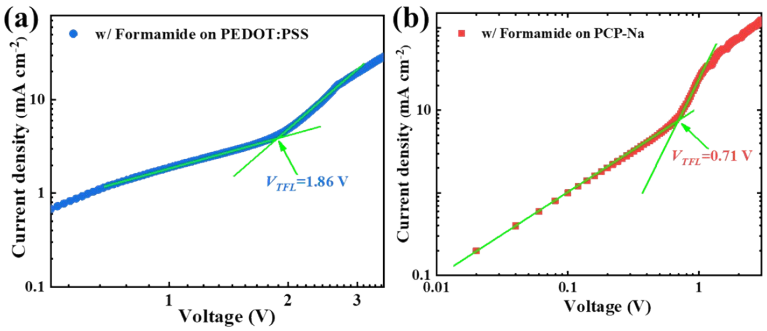

Figure S9. Dark current–voltage measurements of the hole-only devices for the $(BA,GA)_2MA_4Pb_5I_{16}$ perovskite on different substrates. The defect density could be calculated by equation $N_{defects}= 2\varepsilon\varepsilon_0V_{TFL}/eL^2$ (*Science* **2015**, 347, 967) (ε and ε_0 are the dielectric constants of perovskite and the vacuum permittivity, respectively, L is the thickness of the obtained perovskite film, about 300 nm in this study, and e is the elementary charge). When ε is constant, $N_{defects}$ is in direct proportion to V_{TFL}. Therefore, the decrease of V_{TFL} indicating the reduced hole trap-state density.

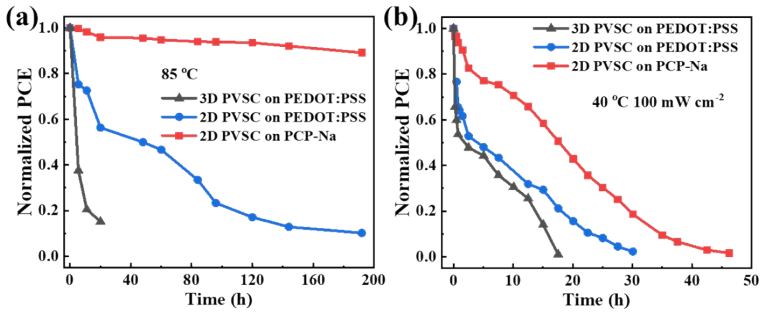

Figure S10. (a) Thermal stability and (b) light stability curves of the 2D and 3D PVSCs on different substrates, respectively.

Table S1. Time-resolved PL data of the $(BA,GA)_2MA_4Pb_5I_{16}$ perovskite films without and with formamide addition on quartz substrate.

	τ_1 [ns]	τ_2 [ns]	frac τ_1 [%]	frac τ_2[%]	τ_{ave} [ns]
DMF w/o f	0.44	3.83	47.92	52.08	2.20
DMF w/ f	1.14	7.87	25.29	74.71	6.17