Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Fully functional semi-transparent perovskite solar cell fabricated at ambient air

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Table 1S: PV parameters when changing the BYK (WE) concentration.

Voc (V)	Jsc (mA/cm^2)	Fill Factor	Efficiency (%)	PbI_2/ MAI concentrations (M)	BYK(%)	AVT(%)
0.68	7.3	63	**3.1**	0.1 / 0.063	1	25
0.69	5.85	59	**2.4**	0.1 / 0.063	2	24
0.68	4.8	54	**1.75**	0.1 / 0.063	3	26

Table 2S: PV parameters when changing the MAI concentration.

Voc (V)	Jsc (mA/cm^2)	Fill Factor	Efficiency(%)	MAI Conc. (M)	AVT(%)
0.65	3.9	63	**1.6**	0.013	43
0.62	5	52	**1.65**	0.032	35
0.68	6.2	64	**2.7**	0.044	37
0.71	10.7	61	**4.65**	0.063	28

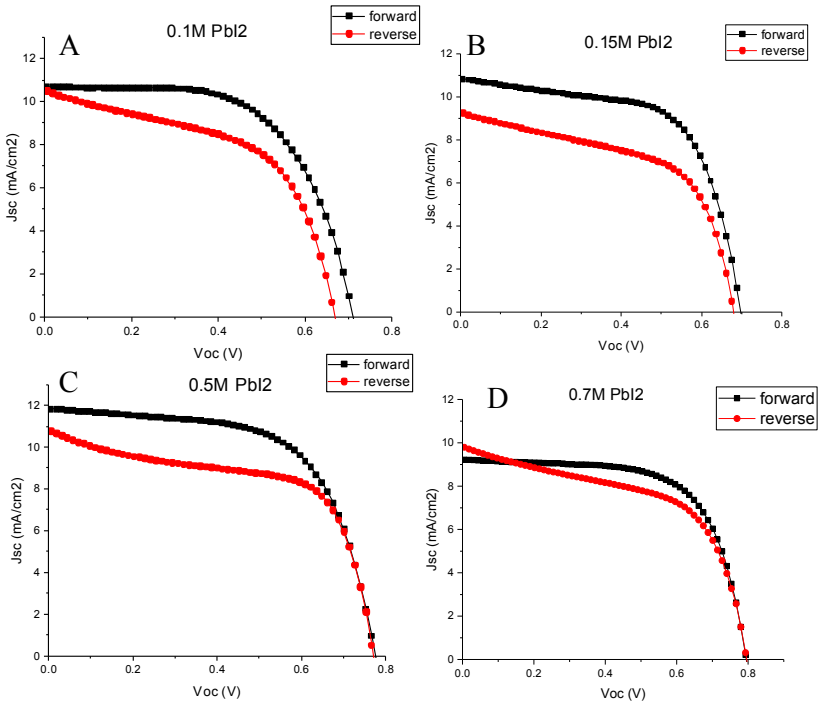

Figure 1S: The hysteresis curves for different PbI2 concentrations , the cells were fabricated using the 85 micron mesh size.

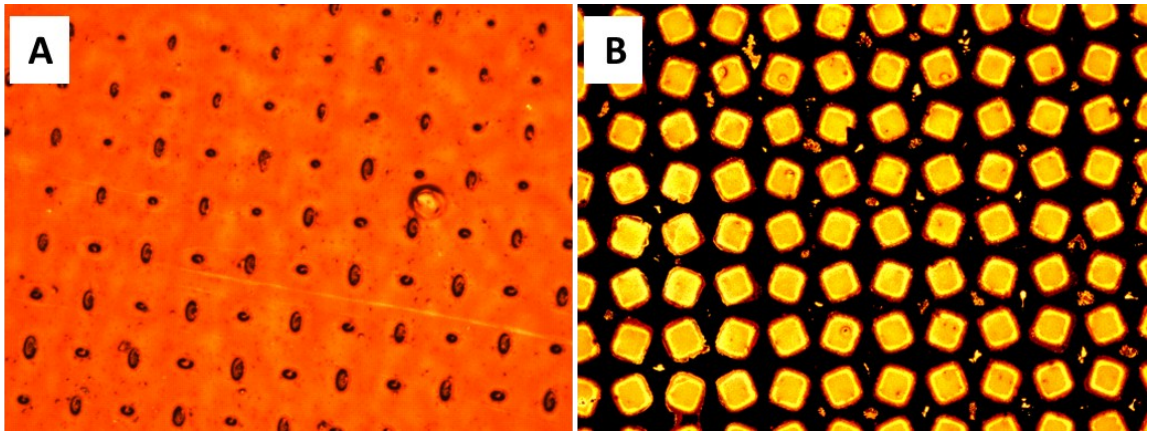

Figure 2S: light microscopy images (magnification X5) for perovskite grids made by (A) 0.1M and (B) 1M PbI_2 solution on 85 µm mesh size.

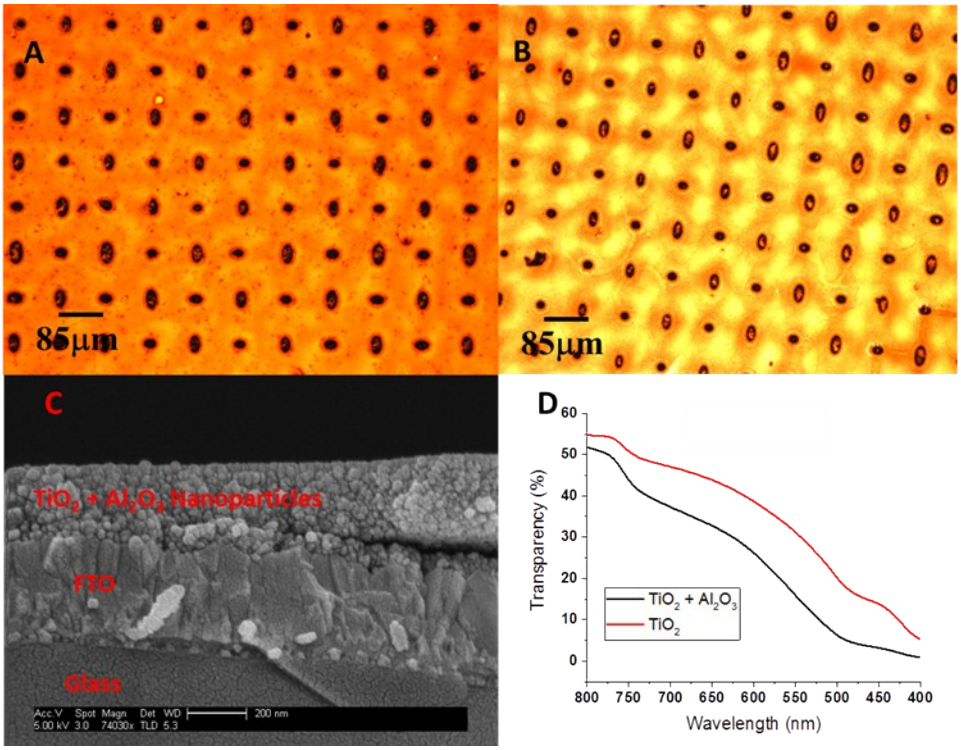

Figure 3S: (A) Optical microscope image of PbI_2 islands on meso TiO_2 +Al_2O_3 NPs. (B) Optical microscope image of PbI_2 islands on meso TiO_2. (C) HRSEM cross section of the photoanode. (D) The transparency of electrode composes of PbI2 islands (made by 2M of PbI2) on meso TiO_2 and on meso TiO_2+Al_2O_3 NPs.

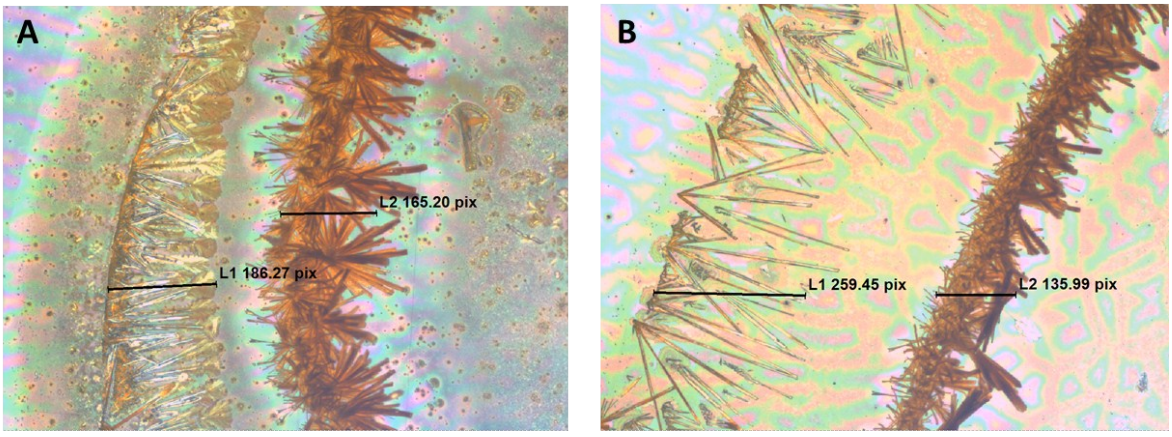

Figure 4S: drying PbI_2 droplets of the same volume deposited onto (A) Al_2O_3 and (B) TiO_2 substrates.

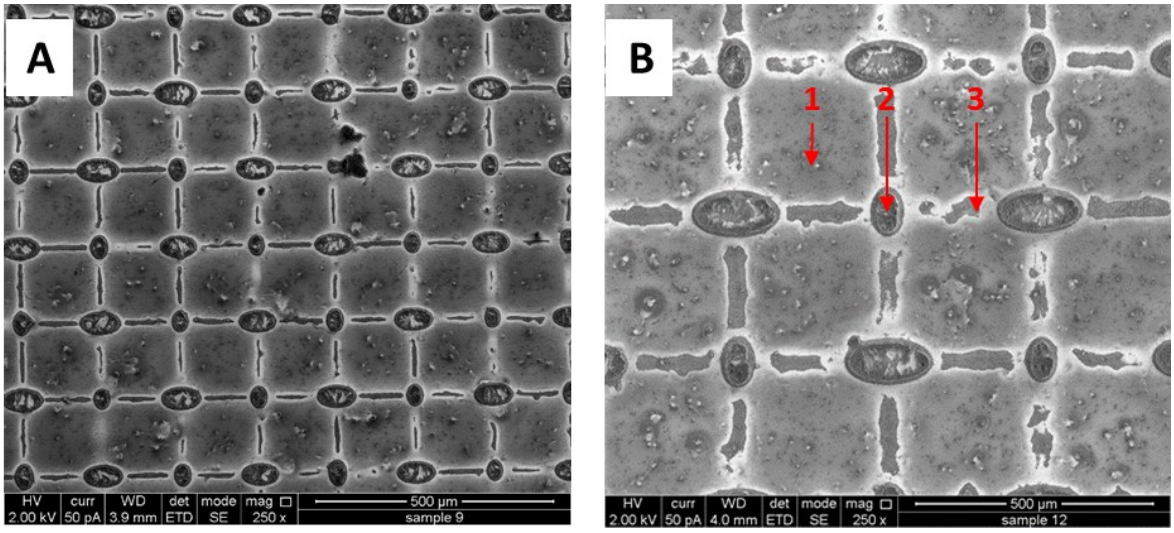

Figure 5S: PbI_2 grid on top of mesoporous TiO_2 and Al_2O_3 NPs after annealing to 70℃ using (A) 85 µm and (B) 220µm mesh size.

Table 3S: EDS measurement for the PbI_2 grid.

Area	Mesh size (µm)	Pb (%)	I (%)	Ti (%)
1	85	2.52	1.19	11.83
	240	2.28	1.81	15.7
2	85	37.79	62.21	--
	240	36.54	63.46	--
3	85	9.09	10.95	18.1
	240	32.64	45.15	12.46

Calculations for the real active area were performed by first measuring the grid line thickness and then calculate the number of lines according to the mask size (0.04 cm^2):

$$\#lines\ in\ one\ edge = \frac{length\ of\ the\ edge}{mesh\ opening\ size}$$

The total number of lines in the active area was calculated by:

$$total\ num\ of\ lines = 2 \times (\#lines\ in\ one\ edge)$$

In order to find the real active area i.e., the area that covered with perovskite beneath the counter electrode:

$$real\ active\ area\ (\%) = \frac{area\ of\ a\ line \times total\ num\ of\ lines}{total\ active\ area} \times 100\%$$

Table 4S: The Average PV parameters for the perovskite grid on m.p TiO_2.

Voc (V)	Jsc (mA/cm2)	Fill Factor (%)	Efficiency (%)	PbI_2 conc. (M)	mesh size (μm)	AVT %
0.59	5.4±0.2	56.4±1.6	1.8±0.1	0.2	85	33.99±0.5
0.59	5.9±0.5	57.8±2.2	2±0.1	0.1	85	36.69±1.9