Supplementary information

Two-dimensional or passivation treatment: the effect of Hexylammonium post deposition treatment on 3D halide perovskite-based solar cells

Stav Rahmany and Lioz Etgar*

The Hebrew University of Jerusalem, Institute of Chemistry, The Center for Nanoscience and Nanotechnology, Casali Center for Applied Chemistry, Jerusalem 91904, Israel
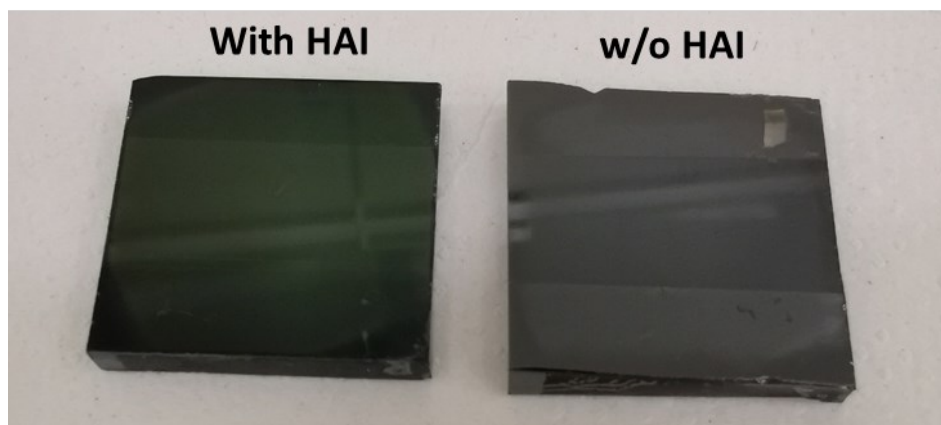
* lioz.etgar@mail.huji.ac.il

Figure S1. Photo of the 3D perovskite film on top of the TiO_2 substrate with and without HAI treatment.
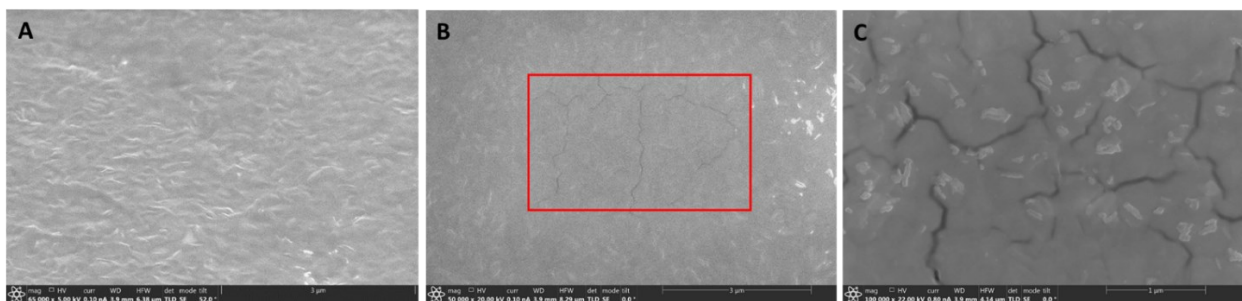

Figure S2. Scanning electron microscopy of (A) the surface of the perovskite/HAI structure, (B) the perovskite/HAI surface after removal of the HAI layer by the electrons beam where the red square shows the perovskite grains underneath the HAI. (C) Enlargement of the area where HAI was before it was removed by the electrons beam.

Table S1: PV parameters as a function of the post deposition treatment.

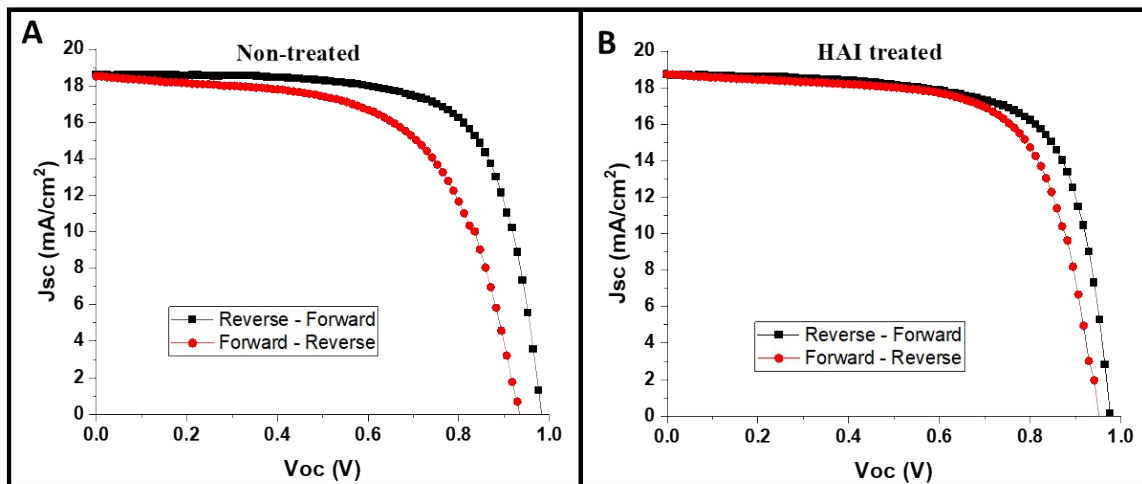| Post deposition treatment	V_{oc} (V)	J_{sc} (mA/cm^2)	Fill Factor (%)	Efficiency (%)
IPA	0.97 ± 0.04	19.3 ± 1.9	66 ± 3	12.3 ± 1.4
HAI 2 mg/ml	0.95 ± 0.05	20.2 ± 1.4	64 ± 3	12.4 ± 1.5
HAI 5 mg/ml	0.98 ± 0.01	18.7 ± 0.1	68 ± 4	12.5 ± 1.1
HAI 10 mg/ml	1.01 ± 0.01	19.2 ± 0.1	73 ± 1	14.2 ± 0.3

Figure S3. Representing forward (red) and reverse (black) J-V scan graphs for the (A) non-treated and (B) HAI treated devices.

Table S2. Average hysteresis index (HI) for the HAI and non-treated devices..

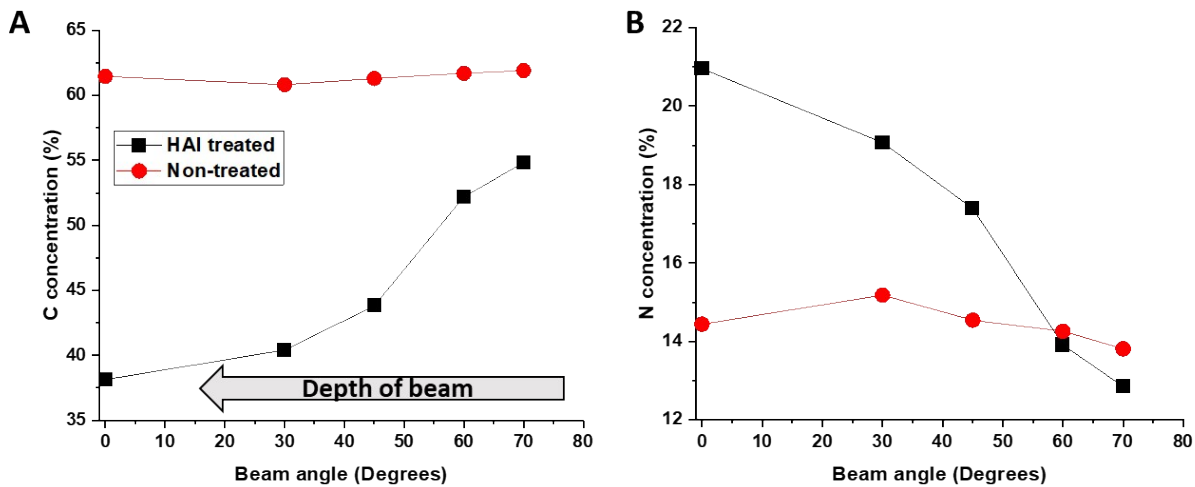| Condition	HI
With HAI	0.070 ± 0.008
W/O HAI	0.181 ± 0.034

Figure S4. Angle XPS measurements showing the (A) carbon and (B) nitrogen atoms concentrations for HAI treated (black) and non-treated (red) samples. As the angle is lower the beam depth is deeper as described by the grey arrow.

Table S3: Calculated d-spacing of the different FFT regions and the corresponding hkl plans.

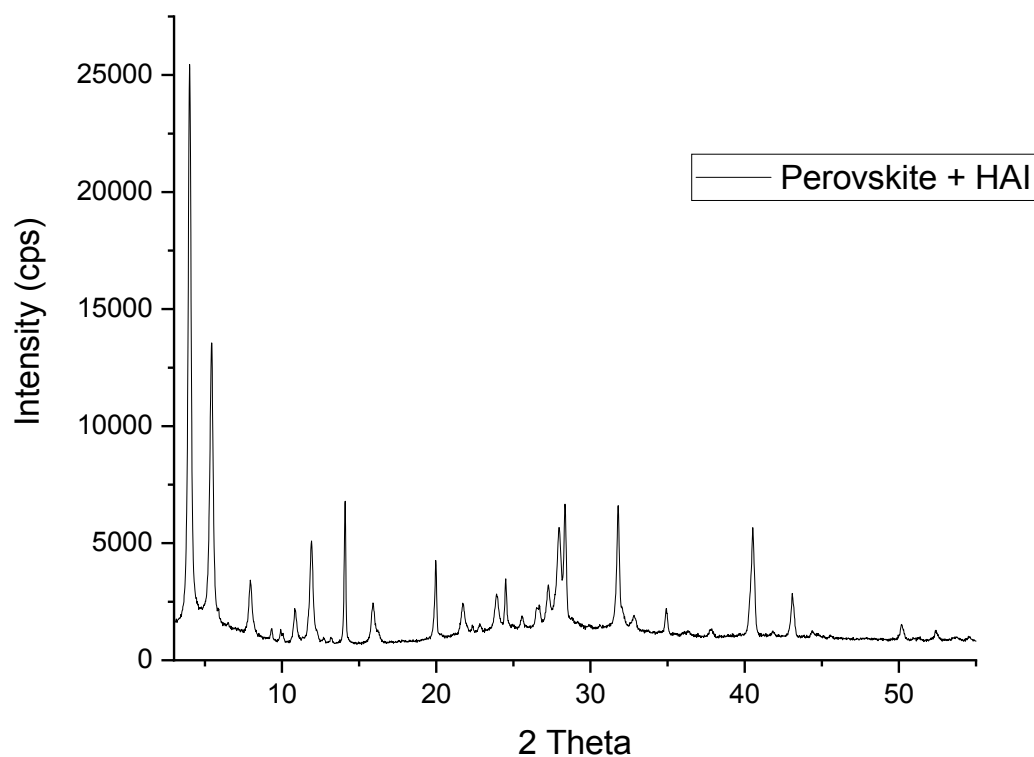| Area	d-spacing	(h k l)
FFT 1	No signal	No signal
FFT 2	2.90	0 2 1
	4.38	0 1 1
FFT 3	2.92	0 2 1

Figure S5. XRD spectrum of the perovskite HAI sample.

Table S4: comparison of the 14.1 degrees perovskite peak intensity and the 2D HA perovskite peaks intensities from the perovskite/HAI XRD spectrum.

2θ	Peak type	Intensity difference compare to perovskite peak	Ratio
14.1	Highest perovskite peak	0	0
10.8	HA_2PbI_4	4617	3.16
21.8	HA_2PbI_4	4305	2.76

Table S5: comparison of the 4.0 degrees HAI peak intensity and the 2D HA perovskite peaks intensities from the perovskite/HAI XRD spectrum.

2θ	Peak type	Intensity difference compare to HAI peak	Ratio
4.0	HAI	0	0

10.8	HA_2PbI_4	23320	12
21.8	HA_2PbI_4	23008	10.5