SUPPORTING INFORMATION

Effect of storage cycle on improvement in photovoltaic parameters of planar triple cation perovskite solar cells

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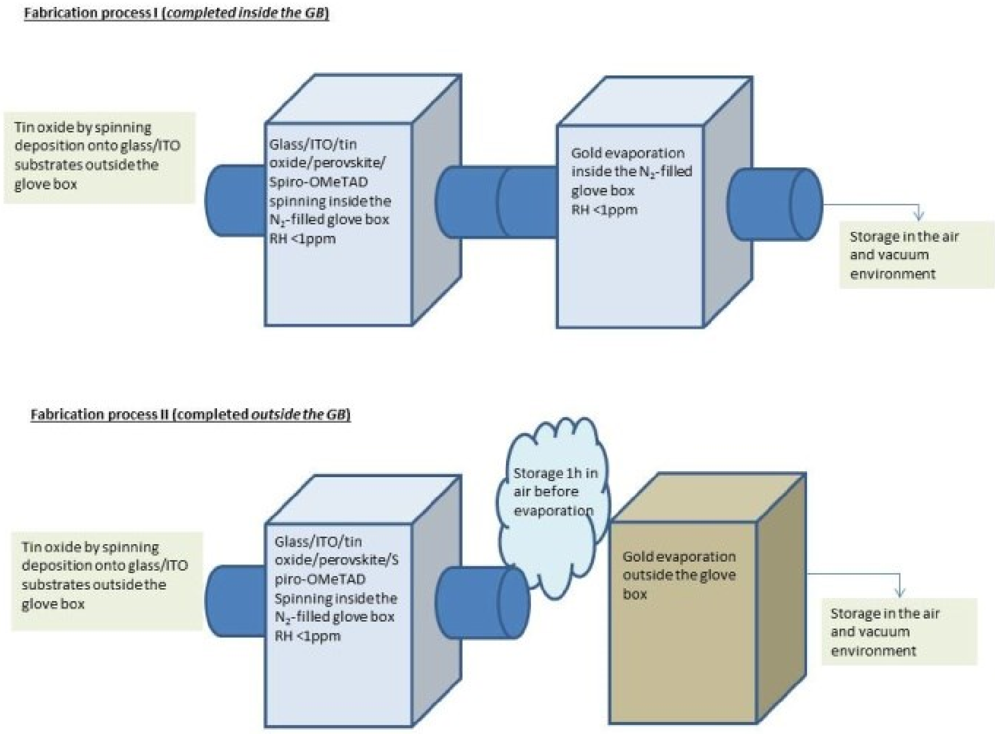
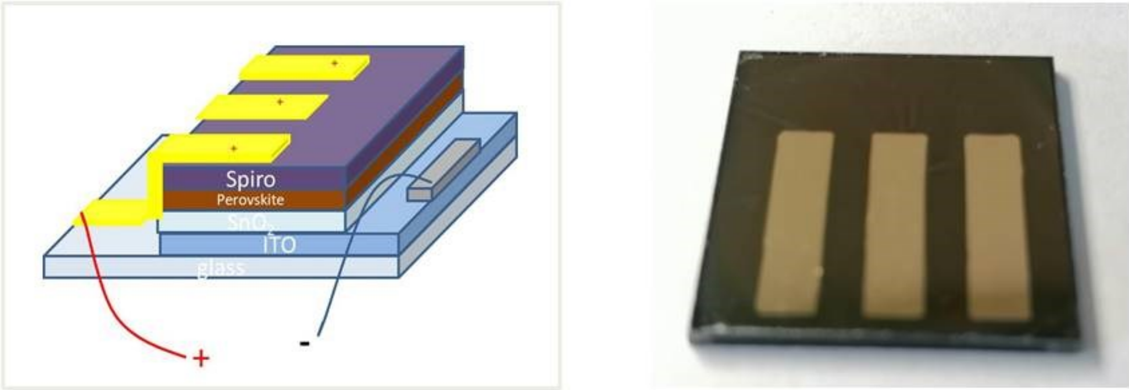


Fig. S1 schematic diagram of the two different fabrication procedures of PSCs: fabrication process I and II. After SnO_2 deposition in humid air onto glass/ITO, substrates were inserted in N_2-filled glove box, with RH<1ppm and perovskite and HTM are deposited by spinning onto glass/ITO/SnO_2. The former batch (a) was inserted into another N2-filled glove box, with a thermal evaporator for Au electrical contact deposition (*devices completed inside the GB*). The latter (b) was transferred outside the glove box using an evaporator in another laboratory (*devices completed outside the GB*). The time in air, between the time from transferring and loading in another evaporator, is about 1h. All the devices were stored in humid air, RH = (30 ± 10) %, and finally placed in low vacuum chamber.



(a) (b)

Fig. S2: (a) architecture of single-junction perovskite solar cell; (b) photograph of typical perovskite solar cell, 2 x 2 cm^2 with gold contacts before silver deposition on ITO. Active area is 0.11 cm^2

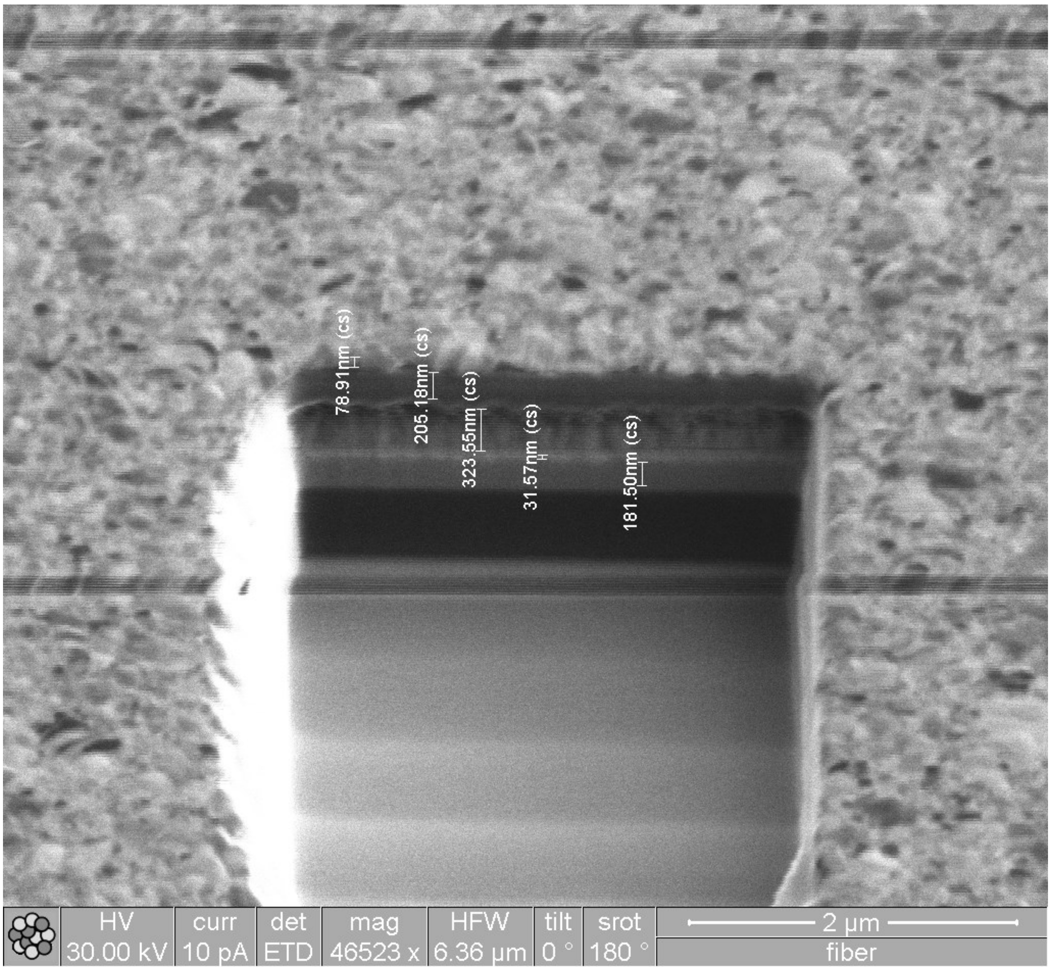


Fig. S3: Ion image of FIB cross section of a typical device with values of layer thickness measured by software of Quanta 200 3D

Table S1 Summary of efficiency of PSCs respect to ambient fabrication or storage conditions in function of perovskite chemical composition, thickness and architecture (*capping layer)

Perovskite	Thickness (nm)	Architecture	Fabrication or storage condition	PCE (%)	Ref.
MAPI	~ 400	ITO/Planar SnO_2/C60-SAM/perovskite/Spiro-OMeTAD/Au	under atmospheric conditions (RH=50%)	18.7	Ugur et al. 2020 [11]
$(FAPbI_3)_{0.85}(MAPbBr_3)_{0.15}$	~ 400*	FTO/compact TiO_2/mesoTiO_2/perovskite/Spiro-OMeTAD/Au	Ambient RH=(20± 10)%	20.4	Cho et al 2021 [46]
$Cs_{0.05}(MA_{0.17}FA_{0.83})_{0.95}Pb(I_{0.83}Br_{0.17})_3$	not reported	FTO/compact TiO_2/meso TiO_2/perovskite/Spiro-OMeTAD/Au	Ambient moderate humidity (RH=40%)	14.8	Mesquita et al. 2020 [9]
$(FAPbI_3)_{0.97}(MAPbBr_3)_{0.03}$	760 650	ITO/SnO_2 / perovskite/Spiro-OMeTAD/Au	Ambient air (RH=30/40%)	19.9 20.9	Jiang et al 2017 [69, 75]
$C_2H_5PbI_3$	~170	FTO/SnO_2/perovskite/Spiro-OMeTAD/Au	Ambient air (RH =20/30%)	17.38	Zhang et al 2020 [16]
$Cs_{0.05}FA_{0.8}MA_{0.15}PbI_{2.5}Br_{0.5}$	**320**	**ITO/SnO_2 / perovskite/Spiro-OMeTAD/Au**	**Ambient air (RH=30± 10)% and low vacuum**	**20.9**	**This work**

Table S2: Average and best parameters of devices completed outside the GB over storage time in humid air/low vacuum environment cycle

Time (h)		V_{oc} (mV)	J_{sc} (mA/cm^2)	FF (%)	PCE (%)
0	*Average*	916 ± 5	23.6 ± 0.1	55.3 ± 0.9	12.0 ± 0.3
	Champion	922	23.70	56.3	12.2
72 (humid air storage)	*Average*	1013 ± 12	22.9 ± 0.2	72.8 ± 2.9	17.0 ± 1.0
	Champion	1017	22.86	74.8	17.4
312 (humid air storage)	*Average*	1064 ± 16	21.4 ± 0.1	72.5 ± 2.6	16.5 ± 0.9
	Champion	**1083**	**21.76**	**74.1**	**17.5**
720 (vacuum storage)	*Average*	1068 ± 12	23.4 ± 0.6	74.8 ± 5.6	18.7 ± 2.1
	Champion	**1083**	**24.72**	**73.6**	**19.7**

Table S3: Average and best parameters of *completed inside the GB* devices over storage time in humid air/low vacuum environment cycle

Time (h)		V_{oc} (mV)	J_{sc} (mA/cm^2)	FF (%)	PCE (%)
0	*Average*	977 ± 30	21.5 ± 0.9	61.4 ± 3.8	12.7 ± 1.6
	Champion	975	22.1	61.4	13.2
72 (humid air storage)	*Average*	1104 ± 16	23.4 ± 0.8	77.3 ± 3.6	19.9 ± 1.9
	Champion	**1080**	**23.58**	**81.6**	**20.8**
312 (humid air storage)	*Average*	1086 ± 25	21.1 ± 0.8	76.1 ± 4.8	17.4 ± 2.2
	Champion	1074	21.40	81.6	18 .8
720 (vacuum storage)	*Average*	1110±30	23.6 ± 0.4	76.0 ± 3.4	19.9 ± 1.8
	Champion	**1121**	**24.07**	**77.3**	**20.9**

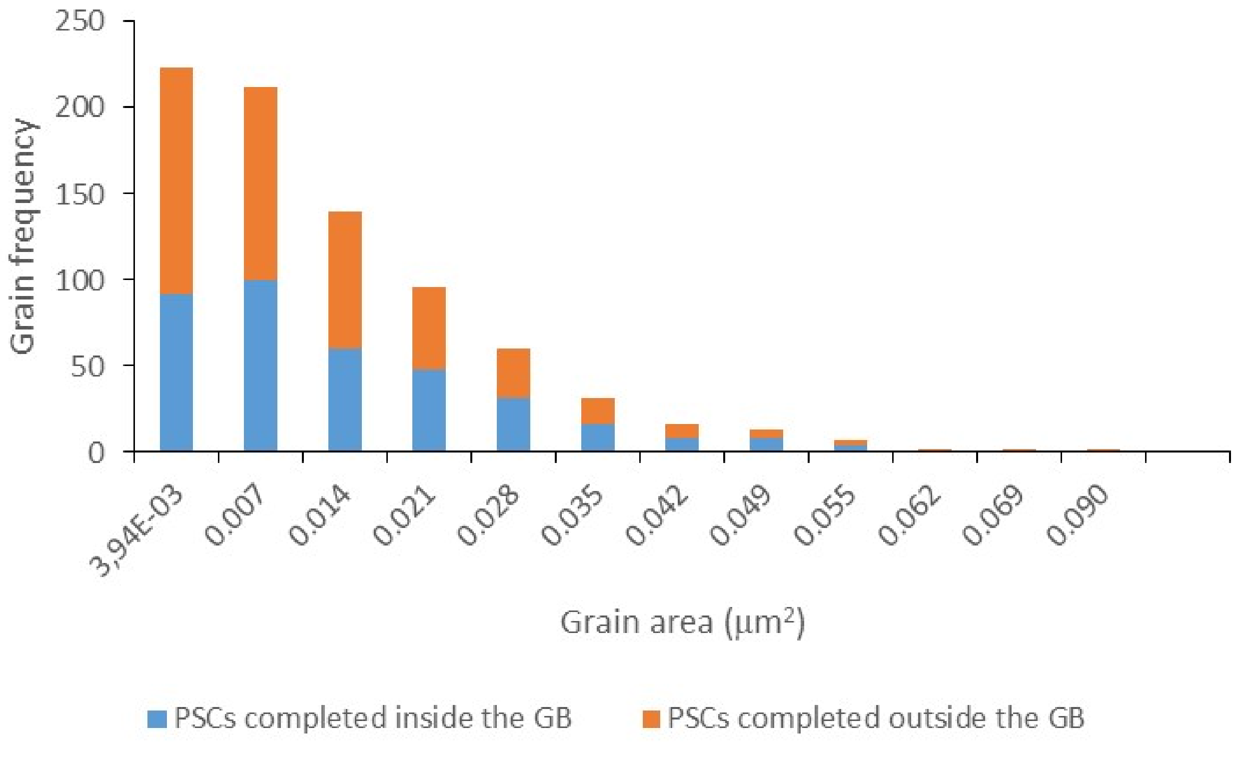


Fig. S4: distribution of grain area of devices completed inside (blue) and outside (orange) the GB . PSCs completed outside show a larger grain population of small area respect to area size of grains of devices completed inside the GB

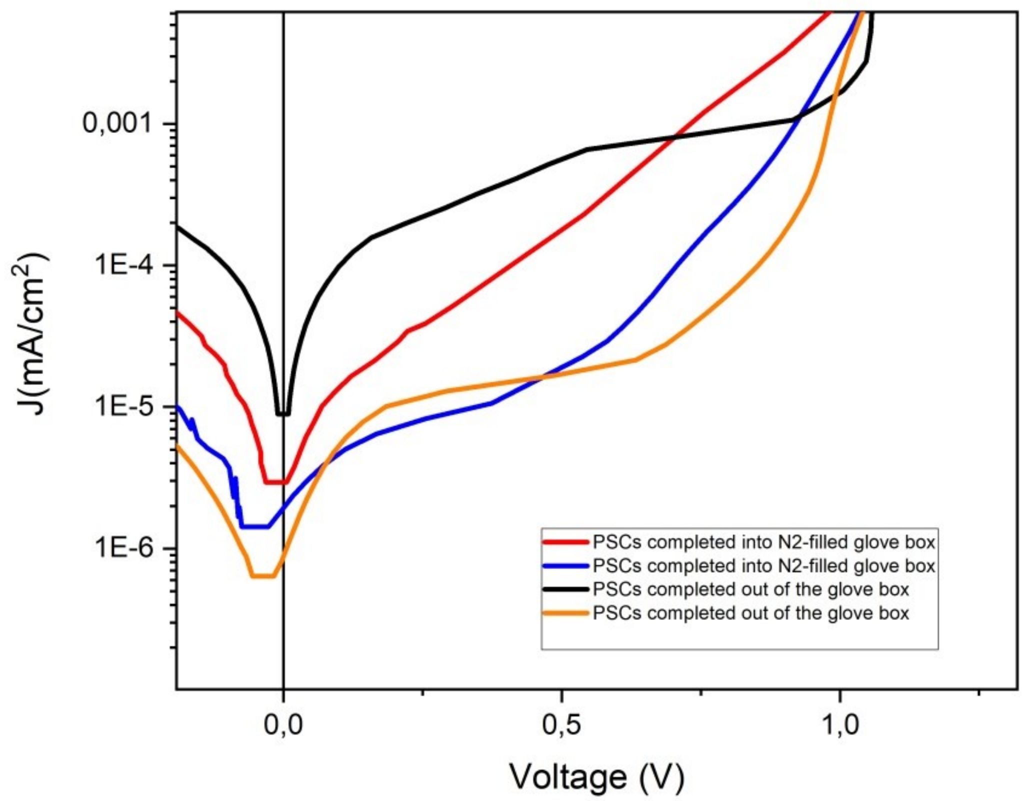


Fig. S5: dark J-V of different stored devices after 720 h from fabrication day

Table S4: N_t calculated from equation (1)

	N_t (cm^{-3})
Devices completed inside the GB	$0,9 \times 10^{16}$ $0,4 \times 10^{16}$
Devices completed outside the GB	$1,9 \times 10^{16}$ $1,6 \times 10^{16}$

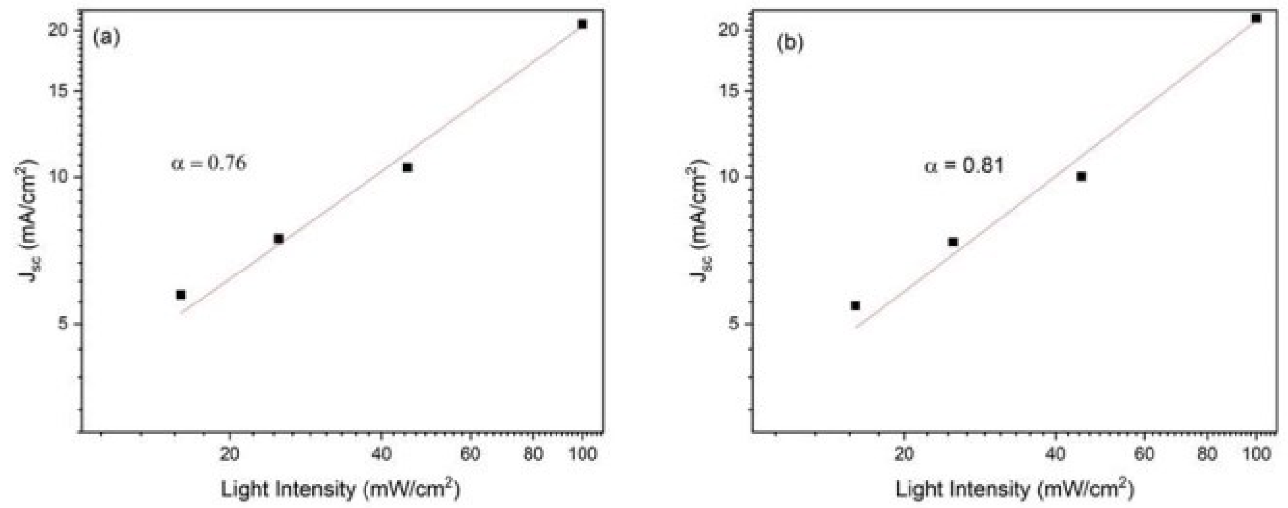


Fig. S6: Intensity-dependent J_{sc} for device (a) completed outside and (b) inside G