Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary information

Figure S1 below shows the XPS diagram of full spectrum measurement on the first day and the seventh day, and figure S3 shows the results of the elements in $MAPbI_3$. From the figure S2, we can see that there is no obvious change in Pb: I in the perovskite, indicating that the composition distribution of the newly formed perovskite surface is similar to that of the perovskite treated with GPC for seven days. In order to further confirm the change of perovskite on the surface after GPC treatment, we marked the N: Pb: I with obvious characteristics in $MAPbI_3$, as shown in Fig. S3. Because the quantitative ratio of N: Pb: I in $CH_3NH_3I_3$ is close to 1:1:3, they represent MA, Pb and I respectively. The results show that there is no obvious residual PbI_2 on the surface of perovskite, and most of the materials are in the form of $MAPbI_3$. XPS can only measure the element distribution at the depth of 10nm on the surface. It cannot do in-depth analysis of perovskite at present. The measurement results (C, N, Pb, I ratio) are seriously distorted by sputter. Therefore, the longitudinal XPS cannot provide meaningful data for discussion due to the damage. The depth information can be explained by TOF- SIMS in the figure 2.

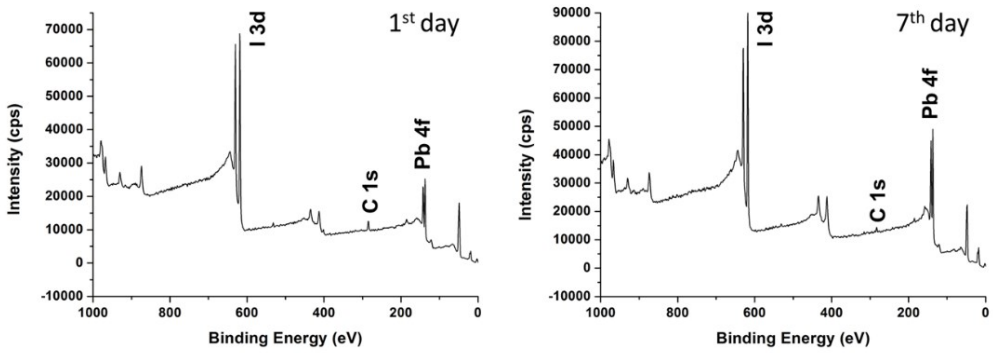

Figure.S1 XPS of full spectrum measurement on the first day and the seventh day

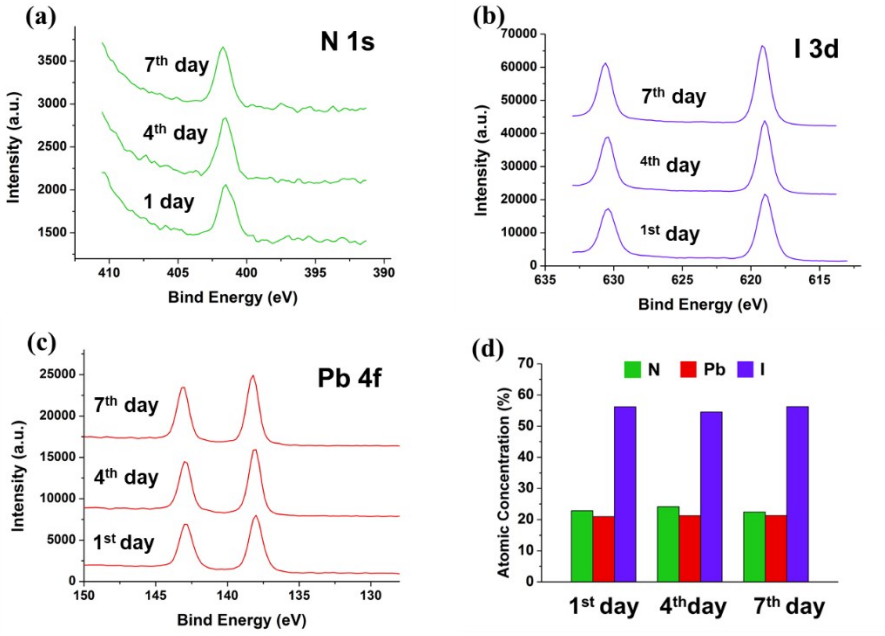

Figure.S2 (a) nitrogen, (b) iodide and (c) lead distribution of MAPbI3 which measured by XPS and (d) the statistical distribution of such elements.

The figure S3 below shows the J-V curves of perovskite solar cells fabricated with SET without GPC and with GPC of 3, 5 and 7 days. From the figure S3, we can see that with the increase of growth time, the $MAPbI_3$ perovskite solar cell with GPC gradually achieves the best performance, and all the parameters are improved

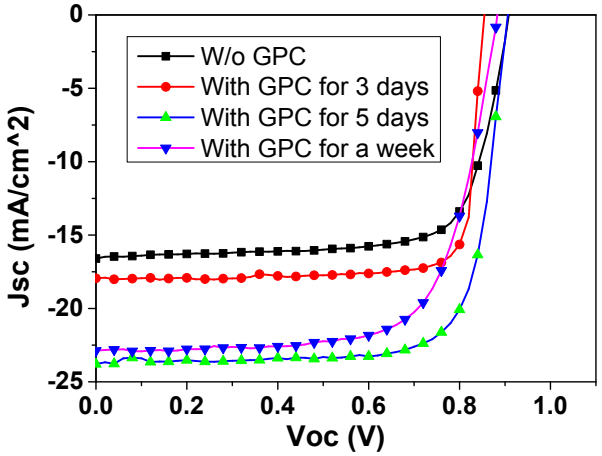

Figure S3 $MAPbI_3$ perovskite solar cell made by SET treated without GPC and with GPC for few days

The following tables S1 and S2 show the component statistics and the RSD calculation results of perovskite solar cell made by SET with and without GPC. Figure S4 and S5 shows the J-V curve of perovskite solar cell made by SET with and without GPC.

Table S1. parameters and RSD calculation of 10 perovskite solar cells which

made by SET and treated without GPC

Without GPC				
Number of cells	PCE (%)	Voc (V)	Jsc (mA/)	Fill Factor (%)
1	10.13	0.82	16.6	74.6
2	10.05	0.86	16	72.84
3	10.3	0.87	16.2	73
4	10.3	0.87	16.1	73.6
5	10.57	0.84	17	73.9
6	10.49	0.85	16.9	73.2
7	10.1	0.88	15.7	73.06
8	10.4	0.88	15.8	74.6
9	10.1	0.87	15.5	74.9
10	10.1	0.87	15.5	75.13
Standard Deviation (SD)	0.185	0.019	0.546	0.863
Average	10.254	0.861	16.13	73.883
Relative Standard Deviation(RSD)	0.018	0.022	0.034	0.012

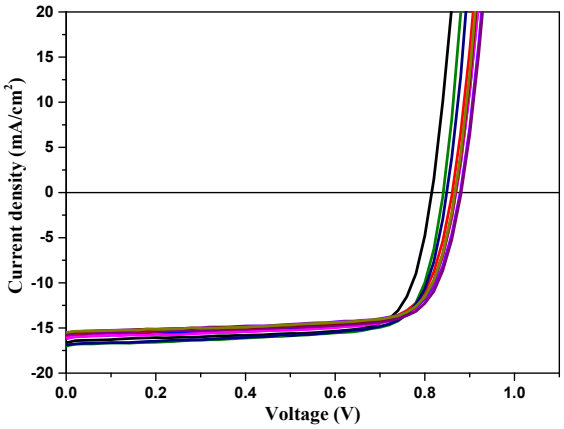

Figure S4. J-V curves of 10 perovskite solar cells which made by SET and treated without GPC

Table S2. parameters and RSD calculation of 10 perovskite solar cells which made by SET and treated with GPC

With GPC				
Number of cells	PCE	Voc	Jsc	FF
1	13.3	0.91	19.3	75.97
2	14.18	0.88	22.9	70.19
3	14.28	0.91	22.1	70.96
4	16.5	0.91	23.66	76.4
5	16.43	0.91	23.79	76.2

6	13.2	0.88	20.74	72.06
7	15.6	0.91	23.1	74.3
8	15.8	0.91	23.3	74.6
9	13.7	0.89	24.04	64.3
10	13	0.91	19	75.2
Standard Deviation (SD)	1.362	0.0132	1.866	3.776
Average	14.599	0.902	22.193	73.018
Relative Standard Deviation(RSD)	0.093	0.015	0.084	0.052

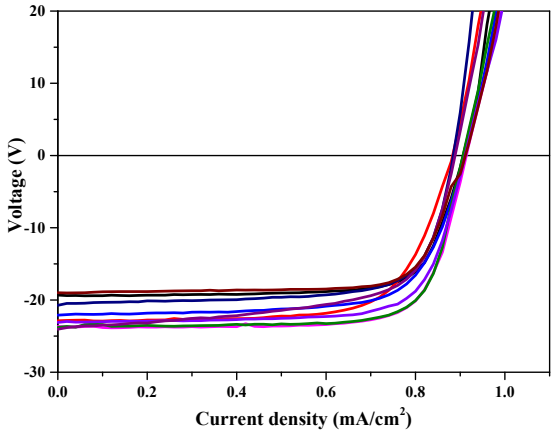

Figure S5. J-V curves of 10 perovskite solar cells which made by SET and treated with GPC