

Supporting information

Table S1. Photovoltaic parameters of devices based on MAPbI₃-xMACl.

| Device | Scan direction | V _{oc} (mV) | J _{sc} (mAcm ⁻²) | FF | PCE(%) |
|-----------|----------------|----------------------|---------------------------------------|------|--------|
| 0 MACl | R-S | 867 | 14.92 | 0.68 | 8.74 |
| | F-S | 830 | 12.41 | 0.47 | 4.80 |
| 0.15 MACl | R-S | 912 | 15.87 | 0.62 | 8.93 |
| | F-S | 901 | 15.05 | 0.48 | 6.47 |
| 0.3 MACl | R-S | 945 | 18.70 | 0.65 | 11.50 |
| | F-S | 951 | 18.78 | 0.58 | 10.33 |
| 0.45 MACl | R-S | 1024 | 20.13 | 0.68 | 14.27 |
| | F-S | 1033 | 20.14 | 0.70 | 14.50 |
| 0.6 MACl | R-S | 953 | 16.28 | 0.61 | 9.39 |
| | F-S | 944 | 16.38 | 0.59 | 9.12 |
| 0.75 MACl | R-S | 956 | 15.69 | 0.62 | 9.26 |
| | F-S | 955 | 15.35 | 0.62 | 9.06 |
| 0.9 MACl | R-S | 957 | 15.21 | 0.58 | 8.46 |
| | F-S | 951 | 15.12 | 0.59 | 8.42 |
| 1.05 MACl | R-S | 917 | 7.82 | 0.66 | 4.70 |
| | F-S | 916 | 7.84 | 0.64 | 4.62 |

Table S2. Photovoltaic parameters of devices based on pristine MAPbI₃ (a batch of 15 devices)

| Sample | V _{oc} (mV) | J _{sc} (mA/cm ²) | FF | PCE(%) |
|---------|----------------------|---------------------------------------|------|--------|
| 1 | 867 | 14.92 | 0.68 | 8.74 |
| 2 | 895 | 14.80 | 0.62 | 7.13 |
| 3 | 862 | 15.22 | 0.59 | 7.73 |
| 4 | 873 | 14.95 | 0.61 | 7.91 |
| 5 | 917 | 13.86 | 0.55 | 7.06 |
| 6 | 907 | 11.78 | 0.54 | 5.74 |
| 7 | 890 | 14.59 | 0.51 | 6.61 |
| 8 | 867 | 12.72 | 0.70 | 7.67 |
| 9 | 844 | 11.27 | 0.68 | 6.50 |
| 10 | 896 | 12.09 | 0.54 | 5.87 |
| 11 | 892 | 12.10 | 0.69 | 7.43 |
| 12 | 869 | 13.43 | 0.65 | 7.54 |
| 13 | 854 | 12.36 | 0.65 | 6.86 |
| 14 | 871 | 13.34 | 0.51 | 5.85 |
| 15 | 854 | 13.39 | 0.68 | 7.73 |
| Average | 877 | 13.39 | 0.61 | 7.09 |

Table S3. Photovoltaic parameters of devices based on pristine MAPbI₃-0.45MACl (a batch of 15 devices)

| Sample | V _{oc} (mV) | J _{sc} (mA/cm ²) | FF | PCE(%) |
|---------|----------------------|---------------------------------------|------|--------|
| 1 | 977 | 19.90 | 0.67 | 13.12 |
| 2 | 987 | 17.16 | 0.71 | 12.08 |
| 3 | 996 | 17.91 | 0.72 | 12.93 |
| 4 | 976 | 18.88 | 0.70 | 12.89 |
| 5 | 972 | 17.76 | 0.74 | 12.37 |
| 6 | 969 | 20.36 | 0.65 | 12.77 |
| 7 | 1009 | 20.17 | 0.69 | 13.95 |
| 8 | 978 | 19.21 | 0.70 | 13.16 |
| 9 | 1000 | 19.42 | 0.72 | 14.04 |
| 10 | 993 | 19.29 | 0.72 | 13.86 |
| 11 | 1024 | 20.13 | 0.69 | 14.27 |
| 12 | 1035 | 19.96 | 0.68 | 14.05 |
| 13 | 1023 | 20.12 | 0.69 | 14.18 |
| 14 | 1003 | 19.32 | 0.73 | 14.15 |
| 15 | 983 | 18.25 | 0.70 | 12.55 |
| Average | 995 | 19.19 | 0.70 | 13.36 |

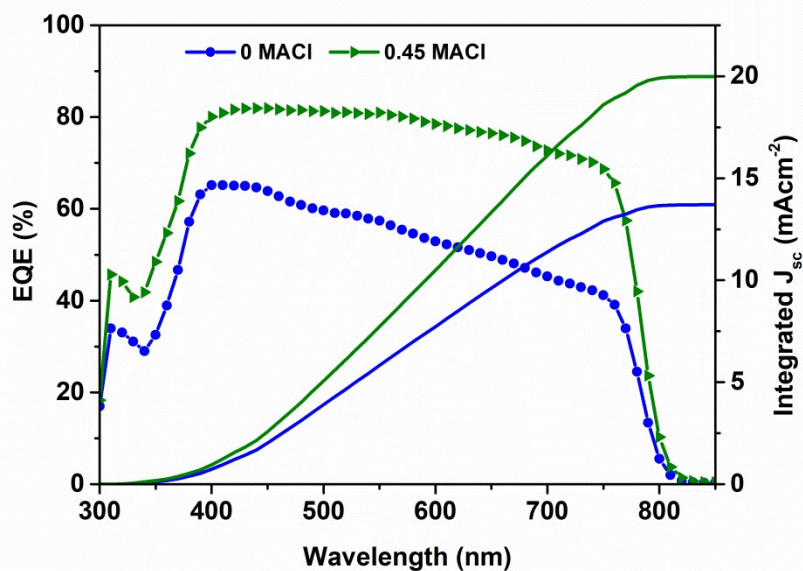


Fig. S1 IPCE spectra and corresponding integrated photocurrents.

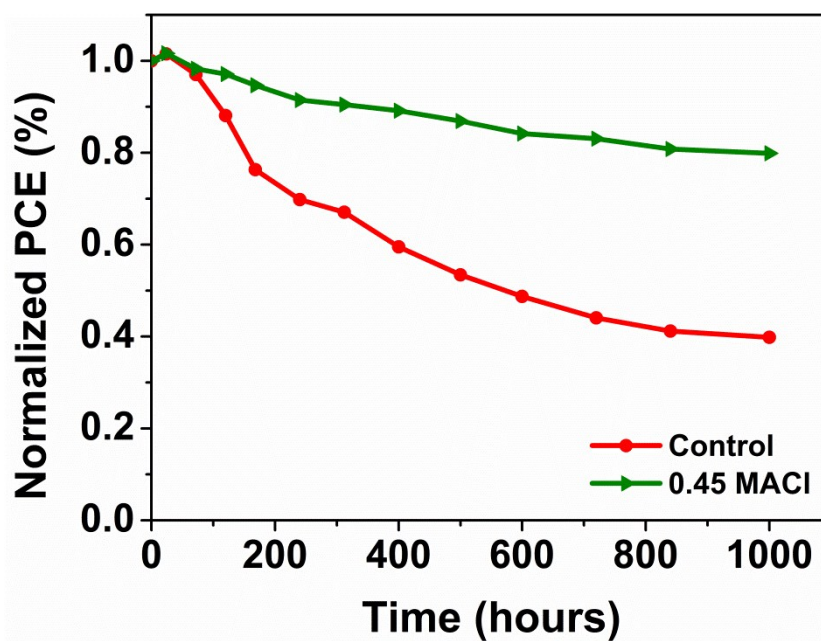


Fig. S2 Long-term stability of the devices with champion recipe (0.45 M MACl).

As shown in Fig. S2, when stored under ambient air condition with 10 ± 5 RH% without encapsulation over 1000 hours, the device based on $\text{MAPbI}_3 \cdot 0.45\text{MACl}$ is extensively enhanced stability in comparison to the pristine one.